AN ECONOMIC GEOGRAPHY OF GREAT BRITAIN

by

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WITH 127 MAPS AND DIAGRAMS

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PREFACE TO FIRST EDITION

THIS book is the product of many years' inquiry and research. It has been gradually built up during that period and has been under constant revision as fresh evidence became available. It does not pretend to paint a complete picture of the economic geography of Great Britain. I have been conscious at all times of drawing outlines, of simply delineating and defining the field. But I have aimed at balance and have in consequence, very reluctantly, shortened my analysis of the present-day agricultural geography. Throughout, I have endeavoured, wherever possible, to measure as well as to describe, to be both quantitative and qualitative. I have worked on primary sources of many kinds, and have made extensive inquiries in the field. Great Britain presents, however, such an infinitely varied rural and urban landscape, laboriously and meticulously created by centuries of human labour working on an already rich diversity of physical terrain, that a single individual cannot be equally familiar with the whole of such a complex panorama. I have read and, from to time, used a wide variety of secondary sources, reference to some of which appears in footnotes. This book was written and set up in type, however, before the publication of Professor L. D. Stamp's *Land of Britain: Use and Misuse*, and Professor Sargant Florence's *Investment, Location and Size of Plant.*

The maps have been drawn partly by myself and partly by Mr. R. T. White and Mr. A. G. Hodgkiss, with help from several others. Acknowledgements to some in respect of individual maps are given in footnotes. I am greatly indebted to the University of Liverpool for a grant from its Research Fund to meet the cost of such cartographical assistance. I am indebted to the following for permission to publish: to Dr. William Davies for Figs. 23 and 24; to the Ministry of Agriculture and Fisheries for Fig. 33; to the Ordnance Survey for Figs. 44–47 and 83; and to the Editor of *Geography* for Figs. 30–32 and 66 and 67.

I have received help in one form or another from literally hundreds of people, to all of whom I tender my thanks. I have been given much encouragement by my colleagues, both past and present, in the Liverpool Department of Geography, and by the interest which so many have shown in the progress of the book. But my chief debt is to my wife, who has given me freely innumerable hours of her time, and who has helped me extensively from her knowledge of economic and social conditions.

WILFRED SMITH

March 1948

PREFACE TO SECOND EDITION

THIS second edition is a revision of the first. The interval of three years between the writing of the first edition and its revision has seen the revival of certain statistical series which were in abeyance at the time of the first edition: railway and shipping traffics and commodity returns by ports are examples. Revision, however, was completed before the publication of the returns of the 1948 Census of Production and of the 1951 Census of Population. It has been possible, therefore, to include some comparative maps of pre-war and post-war distributions. Moreover, it is possible now to see more clearly than it was in 1948 the lineaments of post-war Britain, even though so many of those lineaments are still cast in shadow. The later part of Chapter XV has been entirely re-written and an essay on the location of industry by materials has been added as Appendix C.

I am indebted to those who have pointed out obscurities in argument or in phrasing and I have endeavoured to re-cast sentences accordingly. I am grateful to Sir John Russell for some comments on Chapters IV and V. I have been enabled to re-write several paragraphs of Chapter XIII by reason of work on flour-milling by Mr. J. M. Smith of the University of Nottingham which he has kindly placed at my disposal. I am grateful to many others who have given me information on specific points, especially to my colleagues and members of the Liverpool Department of Geography.

I am indebted to the Milk Marketing Board for the data for Figs. 28 and 29, to the Board of Trade for the data for Figs. 86C and 86D, and to Mr. J. M. Smith for the data for Figs. 78, 79A and 79B. These new figures have been drawn by Mr. A. G. Hodgkiss.

WILFRED SMITH

July 1951

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INTRODUCTION

THIS book is an economic geography of Great Britain. The definition of Great Britain presents no difficulty. Comprising England, Wales, and Scotland, it is a physical unit and a compact political unit girt by the sea. Ireland is excluded. Eire is politically independent, and it has reversed its former condition of economic integration with Great Britain. Northern Ireland is politically separate to a greater degree than Scotland or Wales, but it does not desire the separatism of Eire and has not aimed at the same economic self-sufficiency. Eire must be excluded and, as a corollary, Northern Ireland also, for it would be unsatisfactory to include the one and not the other.

The definition of economic geography is more difficult. It is easier to define places than concepts. The view taken in this book is that economic geography is one facet of the whole geographical complex, its special field being the analysis of the distribution forms or patterns of economic life. These display an extraordinary richness and variety and embody the effects of the whole complex of factors—physical, economic, technical, cultural, and political—which model economic activity. It would be false, in my opinion, for an economic geography to confine its attention only to those distribution forms which display a demonstrably close association with physical conditions. Some distribution patterns show a closer association than others, and it is one of the objects of this work to trace the varying degrees of this relationship. Economic geography thus offers an almost inexhaustible field for investigation, the more attractive because the distribution forms which it recognizes are in constant movement. Economic geography is not static, though it has its relatively static elements, but dynamic. The physique of the country may be relatively fixed within the span of human history, but human knowledge and technique, which also model economic distributions, are capable of change within a few generations. Only one or two examples are necessary. The distribution of arable cultivation in the twentieth century is, in many respects, the exact converse of that of the Middle Ages. The coke iron industry presents an entirely different distribution pattern from the charcoal iron industry, its predecessor. The roller flour mills of to-day have a sharply contrasted distribution from the rural flour mills of the early nineteenth century. This degree of change runs through the whole range of British economic geography.

The book falls into two parts. The first, the smaller, is historical. In view of the dynamic quality of economic geography, an historical introduction is essential. The logical beginnings of the economic

geography of Great Britain lie far back in pre-history. But, although there has been economic as well as cultural continuity and although remnants of economic patterns, become archaic, have survived into subsequent periods, the development of the economic geography of Great Britain has been punctuated by violent revolutions, and it is divisible into certain clearly defined phases. The revolutions are, firstly, the English Conquest, separating the two very different worlds of the Romano-British and the medieval; and, secondly, the Agrarian and Industrial Revolutions, separating the equally different worlds of the medieval and the modern. These are the divisions of the historian, but they are also of profound significance to the geographer, for the distribution pattern of economic activity was radically different in each phase. The survey of the antecedents of the present economic geography, the substance of Part I, is concerned only with the immediate antecedents, that is, the transformation of the medieval into the modern economy.

The second part is a systematic analysis of the present economic geography item by item—agriculture, industry, transport, and trade. They interlock and affect each other intimately: they have been isolated only for purpose of analysis. It has been possible to take samples only of agrarian regions and of types of manufacturing industry, but they have been chosen to give as wide a range as space would allow of the infinitely varied pattern of the economic life of Britain with its variety of landscape and economic structure, its complex heritage and its exposure to fluctuating world conditions. Transport and trade are, in a sense, secondary and consequential rather than primary and original forms of economic activity; they depend on an existing pattern of farming and industry. But, in another sense, they model farming and industry, geared to produce for sale and dependent on transport from place of production to place of market. Transport services affect the distribution of particular forms of agriculture and of manufacturing industry not only through the physical pattern of ways of transport, but also, as will appear, through the kind and cost of the transport facilities provided. Trade is the very life-blood of a commercial economy such as that of modern Britain, and the concluding chapter on trade permits a definition of the character of the British economy and of its regional variants and of the balance of its several parts.

I have throughout endeavoured to concentrate on the significant and reject the ephemeral, to delineate the long-term and reject the short-term. This is, of course, an easier matter in the historical part of the book than when dealing with the contemporary economic landscape. The difficulty is real enough in times of relatively static economy, but it is present to-day in an intensified form, after the second of two cataclysmic wars and in the midst of the adjustment of the British economy to the changing world conditions of the

twentieth as compared with those of the nineteenth century. The mobilization of the economic resources of Britain for the purpose of the late war, which affected type of farming and location of industry alike, and the persistence of controls and shortages into the present day, which are also modelling farming and industry, are short-term situations superimposed on these long-term trends. The lineaments of the economic geography of Great Britain which I have drawn in the second part of the book are those obtaining at the time of writing so far as they can be ascertained, but some statistical series are not available for post-war years and here and there conditions described are those obtaining on the eve of the late war. The book does not, however, aim at an instantaneous photograph of British economic geography at a single particular point of time. It aims rather at an analysis of the fundamental properties of that economic geography and for this purpose it is necessary from time to time to stand back and view the economic landscape in perspective.

PART ONE

THE ANTECEDENTS OF THE PRESENT ECONOMIC GEOGRAPHY

CHAPTER I

AGRICULTURE

I

THE MIDDLE AGES

IN the Middle Ages a type of farming with self-sufficiency as its main objective was common to all parts of the country.[1] The agricultural unit, the village or hamlet, produced the greater part of its own requirements—of corn for bread and drink, of beasts for meat and clothing. The only articles of necessity which every unit could not itself produce were salt and iron. The self-sufficiency of the medieval village must not, however, be over-emphasized. It is true that extreme local self-sufficiency was general even in the English Plain until the beginning of the twelfth century and in the more remote parts of the country even later still. It had been the custom for noble families to migrate to each of their estates in succession in order to consume the production of the estate on the spot—'this perambulatory feeding', as Prof. N. S. B. Gras describes it.[2] But during the twelfth and thirteenth centuries the lord's estates were in many cases farmed by bailiffs who sent the produce of the demesne to the lord's main establishment or else the monetary proceeds of its sale instead. From this time onwards trade in corn and in other products of the farm gradually developed. By the end of the thirteenth century the manors of the Bishopric of Winchester were selling 70 per cent of their wheat, 67 per cent of their rye, 40 per cent of their barley, and 30 per cent of their oats.[3] These were from the demesne and the percentage sold from the villein's holding would be very much less. In the more remote parts, such as South Wales, farming for market did not begin to emerge until the fourteenth century.[4] The areas of excess wheat production appear to have been the Oxford Clay Vale, the southern part of the Lias Clay Vale, and the loams of East Norfolk. The growth of the towns, which involved a demand for corn beyond the production and capacity of the burgesses' own fields, created internal local markets, and in years of good harvest there was sporadically an export abroad from coastal regions such as Kent, East Anglia, or the East Riding of Yorkshire.

Self-sufficient agriculture implies the production in every locality of the main staples of food whether the quality of the soil be suitable

[1] Treatment throughout is of agricultural and not of tenurial or of social conditions.

[2] N. S. B. Gras, *The Evolution of the Corn Market* (1926), p. 5.

[3] Gras, op. cit., Appendix A.

[4] W. Rees, *South Wales and the March, 1284–1415* (1924), p. 101.

or not. This is the geographical significance of the system. Regional agricultural specialization, whereby one district is almost wholly in arable and another almost wholly in grass in accordance with the qualities of the regional environment and which is possible under a system of commercial farming, was then impossible in any complete form. Corn must have been grown on land more suited to other agricultural employment, and there was, in fact, a low average level of productivity. The average yield of wheat, for example, in the Middle Ages was well under 10 bushels per acre,[1] as compared with 32 bushels, which was the average for the inter-war period of the present day.[2] Better seed and improved technique of cultivation, of course, are also responsible for the increase.

While subsistence farming was everywhere the main objective, there were differences between different parts of the country in field systems, in the relative importance of corn and beasts, in the particular crops grown, and in the particular beasts kept. These variations to a large extent were regional, and they are of considerable geographical interest. There was a varied geographical pattern of agricultural activity. It is not, however, by any means a simple task to substantiate these variations owing to the many difficulties involved in the interpretation of medieval records, and it will be necessary to quote a certain amount of evidence.

The regional field systems which will be distinguished here are, first, the two- and three-field system of midland England; second, the Kentish and East Anglian; and third, the systems of western and northern Britain. The first was essentially an arable system and the last largely pastoral. No attempt will be made to discuss the antecedents of these, for it is with the agricultural geography as developed by the thirteenth century that this account deals.

The main outlines of the two- and three-field system were delineated by F. Seebohm in his classic description in *The English Village Community*.[3] Although Seebohm's interpretation of evidence,

[1] The calculation of the average yield per acre in medieval times presents a difficult problem and involves many statistical adjustments. In the thirteenth century Walter of Henley considered 6 bushels per acre, a threefold increase, a fair return (*Walter of Henley's Husbandry*, ed. by E. Lamond (1890), p. 19), and the author of the anonymous *Husbandry* bound up with it states that wheat 'ought by right' to yield fivefold, but admits that unfavourable weather and poor soil would diminish the yield. Sir William Beveridge calculated the average yield of wheat per acre, 1200–1450, from some hundreds of returns to be just under fourfold (3·89:1) or 9·36 bushels (approximately 7·5 modern bushels). See Sir W. Beveridge, 'Yield and Price of Corn in the Middle Ages', *Economic History*, no. 2 (1927); M. K. Bennett, 'British Wheat Yield per Acre for Seven Centuries', *Economic History*, no. 10 (1935); R. Lennard, 'Statistics of Corn Yields in Medieval England', *Economic History*, nos. 11 and 12 (1936 and 1937). See also Sir W. Beveridge, *Prices and Wages in England from the Twelfth to the Nineteenth Centuries* (1939).

[2] This is the average for the ten years, 1924–33; it was 32½ bushels for the ten years, 1929–38.

[3] F. Seebohm, *The English Village Community* (1883).

some of which referred to the Hitchin tithe map of 1816, has been criticized, the reality and antiquity of the system are unquestioned. Prof. H. L. Gray has collected evidence dating from the late twelfth, the thirteenth, and the fourteenth centuries from 422 townships in twenty-four counties to show the practice of a two- or three-field system specifically during the Middle Ages.[1] It was a common-field system, though cultivation in common was not peculiar to it. This characterized, to a greater or less degree, most of the other agricultural systems of medieval Britain; it was the rule in medieval Europe, and it has often been encountered elsewhere in the world among peoples at a somewhat comparable stage of culture. Although bound up, no doubt, with the political and social conditions of the period, common cultivation, or co-aration strictly so-called, was certainly required by the ploughing technique of the time. The heavy plough, with its plough team of eight oxen, the commonest implement of the period, was beyond the means of all but the lord in most communities and beyond the means of all who held by villein tenure in every community, so that joint-ploughing with oxen assembled from several tenants was unavoidable.[2] Co-aration was, therefore, the rule.

The particular form which common cultivation took in the two- and three-field system was that of intermixed and unfenced strips[3] in two or three arable fields, all strips in each field growing the same crop in any particular year. The intermixture was probably the

[1] H. L. Gray, *English Field Systems* (1915), Appendix II. This appendix includes 228 references to the fifteenth century and later, in addition to the 422 references of the twelfth to fourteenth centuries.

[2] G. C. Homans gives specific examples. In Bransdale, in North-east Yorkshire, an extent of 10 Edward I required four neighbours, each holding two ox-gangs, to contribute their oxen to make up a plough-team. This was a relatively simple case and the proportions only occasionally worked out so neatly Moreover, as Homans observes, these arrangements were those made for tilling the demesne and that the tenant associated with his neighbours in an identical fashion when working his own land is an assumption, albeit a reasonable assumption (G. C. Homans, *English Villagers of the Thirteenth Century* (1942), pp. 75–82).

[3] The dimensions of the strips, which might include one or more *lands*, varied enormously. For Bedfordshire, G. H. Fowler states that they 'were typically not less than a rood nor more than an acre in area; an acre strip was usually ploughed in four selions, a half acre in two, a rood as one' (*Quarto Memoirs of the Bedfordshire Historical Record Society*). The rood was here approximately 220 yards by 5½ yards, the acre 220 yards by 22 yards, but these are purely generalized figures and it may be asserted that the medieval farmer understood linear measurement and a day's work, but not areal measurement. The average size of parcels listed in a survey of *c.* 1745 of Apsley Guise in Bedfordshire, in each of four open fields, was 0·27, 0·29, 0·30, and 0·28 acre: these were virtually quarter-acre strips. A dowry comprising sixty strips in a total of 32 acres in the North Field at Harleston in Northamptonshire at the beginning of the fourteenth century consisted predominantly (53 out of 60) of half-acre strips (*The Estate Book of Henry de Bray* (Camden Society), vol. XXVII (1916). Later surveys show that this regularity of strip size disappeared with the incidents of inheritance and division. It is often stated that an acre was ploughed in a day's work, which ended at noon, for plough oxen were grazed during the afternoon, but Dr. C. S. Orwin states that a day's ploughing to-day varies between two-thirds and three-quarters of an acre: this is with the aid of lighter and sharper ploughs, and the swifter traction of horses as compared with oxen (*The Open Fields* (1938), p. 36).

result of the practical exigencies of working with a common plough, as described by Dr. C. S. Orwin, but it incidentally ensured to each peasant samples of each type of land. During any one year, where there were three fields, one was in winter-sown corn (wheat or rye), a second in spring-sown corn (barley, bigg, or oats) or pulses, and a third in fallow. Each field grew a different crop each successive year and was fallow every third year: thus was the fertility of the land maintained. Experiments at Rothamsted have demonstrated the value of bare fallow for increasing yield in the immediately succeeding year.[1] The fields had to be roughly equal in size or, where the soil varied in quality, of roughly equal productivity, for the same amount of food was required each year. Prof. Gray lists the following from an extent of the demesne arable of Brompton, in Somerset (16 Edward III): 49 acres sown with wheat *in campo occidentali*, 60 acres with spring corn *in campo boriali*, and 39 acres fallow *in campo orientali*.[2] Brompton had three fields. *The Estate Book of Henry de Bray* gives an example of a two-field system for Harleston, in Northamptonshire: 50 acres *in campo boriali* and 50 acres *in campo australi*.[3] Where the arable was in two fields only, one was in fallow and the other partly in winter corn and partly in spring corn. The crops were all for human consumption, except some of the oats as provender for horses and perhaps occasionally for other stock.

This arable cultivation seems to have been the chief objective of land utilization in the two- and three-field system, and of the farm stock the most important were the plough oxen. It was an arable rather than a pastoral system. Nevertheless, pasture arrangements were carefully regulated. Stock were depastured on the waste the whole year through, on the fallow until ploughed for winter corn, on the unploughed pieces within the arable fields for tethered stock even when crops were growing, and on the stubble and after-grass of the meadow after corn and hay had been led. Meadow hay, the chief winter stock food, was very valuable and meadow was usually rented higher than arable.[4] The number of animals which each tenant was permitted to graze was often carefully stinted and the dates on which corn and hay stubble could be opened to stock were strictly regulated. The depasturing of stock on the fallow had

[1] *Report for 1936* (Rothamsted Experimental Station), pp. 49–50.
[2] Gray, op. cit., Appendix II, p. 496.
[3] *The Estate Book of Henry de Bray*, pp. 33–5.
[4] 'On the demesne at Apsley in 1295 arable land was valued at only 3*d.* per acre, but the 12 acres of meadow at 2*s.* an acre' (G. H. Fowler, *Quarto Memoirs of the Bedfordshire Historical Record Society*, p. 26). A. Savine (*English Monasteries on the Eve of the Dissolution* (1909), p. 171), extracts from the *Valor Ecclesiasticus* of 1535 particulars of monastic income from several types of land. The average income per acre was 5*s.* 9*d.* for arable, 11*s.* 1*d.* for pasture, and 19*s.* 6*d.* for meadow. These are post-medieval and refer to only a few of the monastic properties, and they must be regarded with further qualifications, but they show the same order of variation as the Apsley values, which are specifically medieval.

some manurial value and assisted in maintaining fertility. The importance of the stubble grazing naturally varied inversely to the quantity and quality of natural grazing available. In those areas where the greatest proportion was under the plough the right of pasturage over the arable fallow was, after the Middle Ages, held so tenaciously that it became perhaps the chief buttress of the system,[1] for the insistence on this right of pasturage prevented the introduction of improved rotations which would eliminate fallow. Such pressure on pasture was, however, probably post-medieval.

Both two- and three-field townships existed side by side by the end of the twelfth century, and Walter of Henley mentions them both in the thirteenth century, but it may be that the two-field was the earlier and more primitive and the three-field the later and more advanced, developed owing to the growth of population. I have classified the references prior to the fifteenth century for 422 townships given in Gray's Appendix II according to the century to which they refer. These are set out in Table I in the form of percentages.

TABLE I

Classification of References to Two- and Three-Fields

	Centuries			
	Twelfth	Thirteenth	Fourteenth	Twelfth to Fourteenth
Two-field	7	53	40	100
Three-field	1	26	73	100

Calculated from H. L. Gray, *English Field Systems*, Appendix II.

These frequencies suggest an earlier date for the two-field arrangement. There are a few examples of a two-field township becoming a three-field[2] and a few of two-field townships becoming four-field, but the nature of the evidence is such that only occasionally are there data for the same township at two different dates. The one change happened, according to Gray, in the thirteenth and fourteenth centuries, the other in the sixteenth and later centuries. It is possible that the two- and three-field systems had each different frequencies not only according to date, but also according to soil. Gray discovers that in Oxfordshire the three-field townships were on the clays and the two-field on the brashy soils of the Cotswolds. The other counties which contained two-field in excess of three-field townships (according to the evidence which Gray collected and which I have plotted on Fig. 1) all have considerable stretches of chalk and Jurassic

[1] E. C. K. Gonner, *Common Land and Inclosure* (1912) and Gray, op. cit., pp 47–8.

[2] An example is also given by T. A. M. Bishop, 'Assarting and the Growth of the Open Fields', *Economic History Review*, vol. VI (1935), p. 19.

upland. Although it would be unwise to strain the evidence too far, it may be that, within the area covered by the two- and three-field system, the three-field was the more frequent on the clays and the two-field the more frequent on the lighter soils of the chalk and Jurassic uplands. T. A. M. Bishop has asserted that the Yorkshire Wolds were under a two-field and the Vale of York under a three-field system:[1] there was the same coincidence of soil contrast. Under medieval methods of arable farming the lighter soils may have been held to require more frequent fallow rests, which the two-field system allowed, and the stronger clays to have been capable of more frequent cropping, which the three-field system required.

Such were the characteristics of the two- and three-field system. It was not the only system of land utilization practised in the country. I have prepared Fig. 1 to display its geographical distribution.[2] According to the evidence of this map it was to be found only in a long midland stretch of England from Durham to Dorset and from the Welsh Border to the western bounds of East Anglia. Gray's own map generalizes this distribution. Orwin also has mapped its extent,[3] but he employed in addition to medieval sources, Enclosure Awards of the eighteenth and nineteenth centuries. Though there were important differences, especially in Norfolk, it was precisely the same area which practised the two- and three-field system that was involved in the enclosure of common arable field in the eighteenth and nineteenth centuries. Enclosure of common arable field by Act as such has been mapped by both Prof. E. C. K. Gonner[4] and Dr. G. Slater,[5] and they both arrive at the same general distribution.[6] Those townships whose common arable field was enclosed by Act in the eighteenth and nineteenth centuries were those which had longest resisted enclosure and where, by inference, the medieval arrangements had longest retained their vitality. The coincidence is so striking that it cannot be wholly fortuitous. Regional differences in agricultural systems operative during the Middle Ages continued thus to have significant consequences well into the nineteenth century.

[1] Bishop, op. cit., p. 17. But see fig. 1.

[2] This map has been constructed from the full list of townships in Gray's Appendix II, 422 of which refer to the twelfth to fourteenth centuries and 228 to the fifteenth century and later. It includes the post-medieval as well as the medieval references. In each of the twenty-four counties in which these townships lie there are, however, examples prior to the fifteenth century. Of the post-medieval references some 22 were drawn from Enclosure Awards.

[3] C. S. Orwin, op. cit., p. 65. Only in respect of Norfolk does this map differ from that based on Gray's evidence and this difference is due to Orwin's use of Slater's lists.

[4] Gonner, op. cit. Map A in Appendix.

[5] G. Slater, *English Peasantry and the Enclosure of Common Fields* (1907). Map opposite p. 73.

[6] Slater maps the total area of individual townships involved in enclosure by Act irrespective of the proportion of the area involved, while Gonner maps the proportions enclosed for registration districts, but not for individual townships.

The second set of field systems was that of the extreme south-east of England—Kent, East Anglia, and, perhaps, the lower Thame Valley.[1] There are many apparent resemblances to midland practice

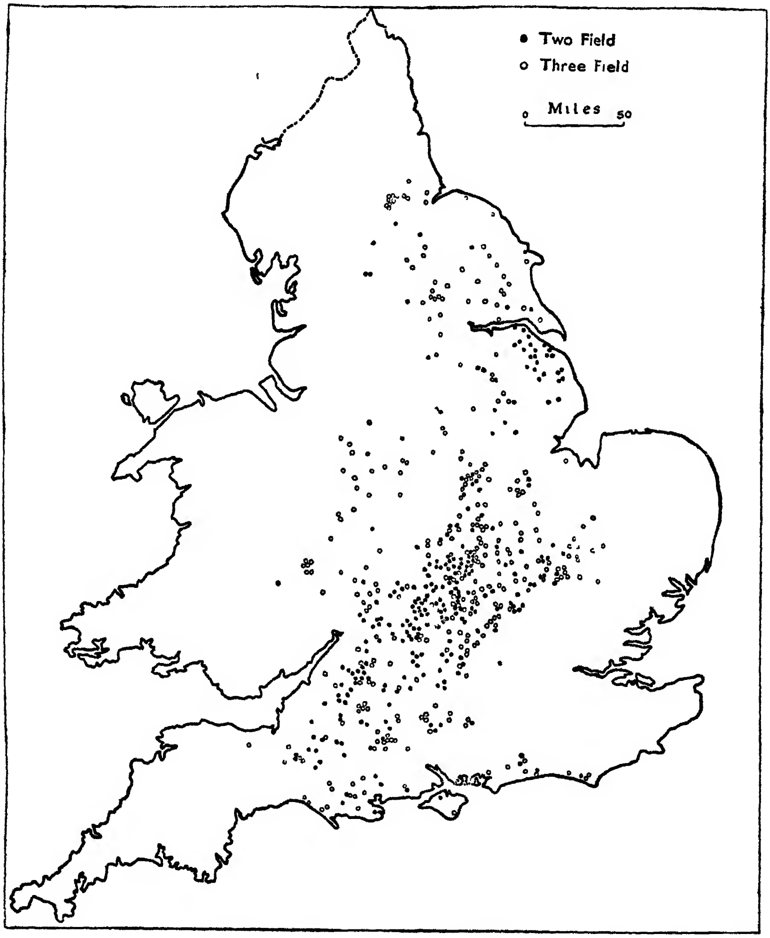


Fig 1

TWO- AND THREE-FIELD TOWNSHIPS IN ENGLAND

Map drawn from evidence collected by H. L. Gray and printed in his *English Field Systems* (1915). Appendix II. Evidence relates to period extending from the thirteenth to the seventeenth centuries The open circles mark the three-field townships, the dots the two-field townships.

and their identity as distinctive systems must not be overstressed. Yet the enclosure maps of Slater and Gonner point to the existence

[1] For the position of Buckinghamshire see W. E. Tate, *A Hand-List of Buckinghamshire Enclosure Acts and Awards* (1946).

of some post-medieval individuality in their agricultural arrangements, for these areas were enclosed before the period of Parliamentary enclosure (indeed, largely before the end of the sixteenth century), and it is necessary to inquire wherein this individuality lay. The individuality of their field systems in the Middle Ages has been discussed in detail by Gray. Later workers—Miss N. Neilson[1] and J. E. A. Jolliffe[2]—confirm the distinctiveness of the agricultural arrangements as they were manifested in Kent, and Prof. D. C. Douglas[3] the distinctiveness of those of East Anglia.

Kent had unquestionably an individuality in its pre-feudal institutions,[4] and these persisted into the Middle Ages as the tenure of gavelkind shows.[5] It is not certain that Kentish medieval cultivation was strictly a common field one, but, as Jolliffe points out, and as a perusal of the *Black Book of St. Augustine* and of the *Cartulary of Bilsington* shows, the holdings were often too small for it to be possible for each peasant to possess a plough-team of his own and co-operation in practice, if not in law, was probable. Land was, in fact, frequently held jointly by co-heirs.[6] A peasant's arable holdings were not, however, as in midland England, in two or three great open fields each bearing a simple descriptive name and following a clearly defined system of farming, but in 'a bewildering number of field divisions . . . giving little clue to the husbandry employed'.[7] Moreover, Jolliffe argues that the agrarian unit was the hamlet rather than the village, an additional point of distinction from the area practising the two- and three-field system. Further, much arable in the middle of the fourteenth century appears to have been sown annually.[8] This land was more valuable, rising to 12*d.* per acre per

[1] N. Neilson, *The Cartulary and Terrier of the Priory of Bilsington, Kent* (1928).

[2] J. E. A. Jolliffe, *Pre-Feudal England: The Jutes* (1933).

[3] D. C. Douglas, *The Social Structure of Medieval East Anglia* (1927).

[4] Jolliffe, op. cit.; also R. G. Collingwood and J. N. L. Myres, *Roman Britain and the English Settlements* (1936).

[5] Gavelkind permitted the division of the holding between heirs, but in practice a holding was often in the hands of a group of heirs or relatives, which contrasted strongly with midland England. The following are examples from *The Black Book of St. Augustine* (1915), ed. by G. J. Turner and H. E. Salter: 'Heredes Philippi de Faireport et heredes Wilhelmi de Boyton tenet XXV acras' (pt. 1, p. 117) and 'Heredes Alexander de Gluocestria et pares de terra Rische tenet XXVIII acras et dimidiam perchiatam' (pt. 1, p. 108).

[6] This holding of land jointly by *heredes*, *fratres*, *socii*, or *pares* was well developed by the end of the thirteenth century. *Heredes* and *fratres* were clearly groups of relatives and *pares* may have described 'still more remotely connected groups' (Jolliffe, op. cit., p. 24). Whatever the relationship of the individuals in these groups, it appears to have been convenient to keep the holdings together, despite the partible inheritance and division of holdings which the custom of gavelkind permitted. There were holdings by *heredes* as late as the fifteenth century constituting 'perhaps 10–20 per cent of the whole' (Jolliffe, op. cit., p. 22), but they were then less numerous than in the thirteenth century. The fifteenth-century *Survey of Bilsington* also lists holdings by *heredes*, though in this instance they would appear to be considerably less frequent than 10 per cent of the whole.

[7] Gray, op. cit., pp. 281–2.

[8] 'possunt seminari quodlibet anno' (Gray, op. cit., p. 302).

annum, than the land fallow every second or third year of the midland system, whose value ranged from 3*d.* to 8*d.*[1] The practice was not general, however, and the records refer only to demesne so managed, but it indicates a greater flexibility of the Kentish as compared with the midland field systems, a flexibility which facilitated early agricultural improvement. Continuous cropping of this kind necessarily implied differences in pasture arrangements for there would be no fallow grazing on such land. The mast of the Weald woods was used for pigs and the coastal marshes of Romney, the lower Stour, and the Thames for sheep and cattle.[2] These were not infrequently many miles removed from the village and physically detached from it. With subsequent increase of population these detached portions achieved independence of their parent and became townships in their own right.

In East Anglia conditions were less distinctive. There was partible inheritance[3] in some communities, it is true, and the holdings were described in terms other than the virgates or yardlands of the two- and three-field system; but these differences relate to tenure. A three-course rotation of crops on the arable has been established for the fifteenth century for North-west Norfolk,[4] but a three-course rotation does not necessarily imply a three-field system, for the rotation may have been applied to the holdings of individuals and not to the village fields as a whole. Features of agricultural (as distinct from tenurial) individuality were not lacking, however. The pasture arrangements were of a special kind. A single township was often divided up into a number of 'fold-courses', each having its own sheep flock which was folded on the arable fallow. Evidence of this dates back to the twelfth century.[5] Though it involved extra labour in moving hurdles, this practice of folding on particular parts of the fallow was a more efficient way of manuring the land than the indiscriminate wandering over the fallow field under the midland system. It was a practice which later proved to be of great importance in the evolution of the Norfolk system of arable husbandry during the eighteenth century. It appears to have been sheep rather than cattle which were involved in this folding, and this implies a further point of contrast with the midland system in which plough oxen had the chief grazing privileges. Folding of part of the fallow appears also to have been the practice in some Essex townships, according to a lease of the twelfth century. At Walton, in Essex, the demesne had 180 acres of fallow, of which 28 acres were twice

[1] Gray, op. cit., pp. 301–2.
[2] Neilson, op. cit. Introduction, pp. 2–56.
[3] Homans, op. cit., pp. 113–17.
[4] For example, George Elmdon of Weasenham, in Norfolk, had 61½ acres under winter corn, 54½ acres of barley (the greater part had had winter corn the year previous), and 48 acres of fallow in 1584 (Gray, op. cit., pp. 318–26).
[5] The evidence from which Gray deduces this is on pp. 341–4.

ploughed (*rebinata*), 33 acres sown (*seminata*), and 11 acres *faldata*, which Hale translated as 'folded with sheep for manure'.[1] Both Gray and Douglas[2] advance the view that the arrangement of arable holdings within the lands of the township in East Anglia was distinctive and different from the scatter of strips in each of the fields which was the rule in the Midland system.

The third group of agricultural systems was that of northern and western Britain, but these northern and western systems were by no means uniform. The evidence for each area must be considered in turn.

In Wales the position was complicated by the Anglo-Norman conquest and the semi-manorialization which followed it. In the *Black Book of St. David's*, which refers to South Wales, the distinction is frequently drawn between land held by the law of England and land held by the ancient tenure.[3] Whether the land in the Englishry, however, was cultivated according to the practices of midland England is by no means certain. At Llantrissent, near Usk on the English Border, which Prof. W. Rees quotes as a typical case, the demesne arable had, it is true, the same acreage under corn each year and in three out of four years had equal acreages of winter-sown wheat and of spring-sown oats, but the fields which grew the corn were individually under a two-course, a three-course, and a four-course rotation.[4] The field system was an irregular one. Of the seven manors in the *Black Book of St. David's* whose demesne arable was attributed to fields specified by name, two had two fields, two had three fields, and three had many fields up to twelve in number.[5] The same irregularity is evident. None of the fields had the simple descriptions, such as East Field or West Field, common in midland England. In the Welshry conditions were very different. Land was held not by individuals, but by a group of relatives, the *gwely*.[6] This was the ancient tenure. The difference was not tenurial alone. The amount of land held by a *gwely* varied greatly: in the 'Country of Landeilo' the arable was as low as four acres, though there was meadow

[1] Leases of manors during the twelfth century bound up with *The Domesday of St. Paul's*, ed. by W. H. Hale (Camden Society) (1858), p. 131.

[2] Douglas, op. cit., p. 45.

[3] *The Black Book of St. David's*, ed. by J. W. Willis-Bund (Cymmrodorion Record Series) (1902).

[4] Rees, op. cit., pp. 192–3. The particulars relate to the successive years 1323–6.

[5] *The Black Book of St. David's*, pp. 73, 109, 119, 137, 171, 229, and 293.

[6] Even in the Englishry much land held by tenants was in the name of co-tenants. In North Wales, at any rate, the gwely organization sometimes cut across the settlement or hamlet organization. A Crown Rental of the sixteenth century relating to Llysddulas in Anglesey reveals seven gwelyau distributed over upwards of twenty-five hamlets: in one of the hamlets each gwely had rights, but at the other extreme some hamlets were in the sole possession of a single gwely (T. J. Pierce, *Bulletin of the Board of Celtic Studies* (1940)). In Chirkland, the Llangollen district, the joint family organization was beginning to decay, however, by 1390 (G. P. Jones, *The Extent of Chirkland* (1933)).

and pasture in addition. The arable, cropped mainly for oats, could not have been the mainstay of the group. Stock rather than corn provided the basis of subsistence and the rent payable to the lord often took the form of cattle or sheep. The Welsh districts were mainly in the hills where arable farming would in any case be limited to small patches. Of a later date (1603), George Owen's *Description of Pembrokeshire* describes practices similar to contemporary outfield cultivation in Scotland, to be described later, although it must not be inferred that the Scottish infield-outfield system was practised in its entirety. There was the night-time folding of stock in summer on land about to be ploughed; there was the sowing of oats 'eight or ten yeares together till the lande growe so weake and baren that it will not yeald the seede: and then let they that lande lie for eight or ten yeares in pasture for their Cattell'.[1] In Cornwall, at the end of the eighteenth century at any rate, similar practices were common.[2]

For North Wales, the *Survey of the Honour of Denbigh, 1334*, gives evidence of somewhat similar conditions to those of South Wales. There was the same distinction between farming in the manors and on the tribal land. There was but a handful of manors and even these exhibited no uniformity in their arable arrangements. Two had arable *in tres seisonas*.[3] But in another the arable is stated *not* to be cultivated in three seasons, and in still another a few acres were noted as sown annually and as having a higher value than the rest. Even the three-course rotation did not necessarily imply a three-field system. In the middle of some of the arable fields was land not worth ploughing through exhaustion[4] and given over to sheep pasture, and among the new meadows was land *in campo*. There was clearly no lack of flexibility and there was no imposition of a rigid field system from England. The tribal land was held similarly in Denbigh to that of the Welshry in South Wales, and stock rather than corn was the main objective of farming.[5]

Medieval evidence for Scotland is not extensive. Down the eastern side of the country land was held in bovates and occasionally it is

[1] G. Owen, *The Description of Pembrokeshire*, ed. by H. Owen (Cymmrodorion Record Series) (1892–7), p. 62.

[2] 'Arable is sown with wheat, barley, or oats, as long as it will bear any; and then grass for eight or ten years, until the land is recovered, and capable again of bearing corn' (R. Frazer, *General View . . . Cornwall* (1794), p. 33).

[3] At Kilforn, 66 acres in the first, 69 in the second, and 66 in the third (*Survey of the Honour of Denbigh, 1334*, ed. by P. Vinogradoff and F. Morgan (1914), p. 4).

[4] 'non valent converti cum aliis seisonas terre arabilis propter eorum debilitatem' (*Survey of the Honour of Denbigh, 1334*, p. 230).

[5] It may be that this was also true of some of the manorialized land. Lay Subsidy Accounts of the reign of Edward I for Lleyn in Carnarvonshire give some data in this connexion. The taxable properties included 352 *boves*, 897 *vaccas*, and 897 *oves*, valued at 5*s*., 3*s*. 4*d*., and 6*d*. per head respectively. It will be noticed that the cows were numerically more important and in the aggregate were worth more than the oxen. The entries for arable produce were considerably smaller in value than the entries for stock (T. J. Pierce, *Bulletin of the Board of Celtic Studies* (1929 and 1930)).

described as lying *in campo*.[1] The bovate was a common descriptive name in the North of England also, as will appear later: it was a measure of ploughing capacity rather than of a precise area and the acreage of a bovate did, in fact, vary within wide limits. The heavy eight-ox plough[2] was here customary, and in the more remote places was in use until the Improving Movement of the Agrarian Revolution. But there is no mention of field names of the *genre* of those of the two- and three-field system and the phrasing in the charters might be held to imply that the bovate formed a compact block of land.[3] In other parts of Scotland there were substantial divergences from this general pattern. In western Scotland and in the Highlands horse-gangs and not bovates or ox-gangs were specified, the plough employed was small and light and the traction was provided by four small horses or ponies. In parts of the Highlands it is probable that even the light plough was replaced by the *càs chrom*, or foot plough, which permitted only a small plot or croft as distinct from a field type of cultivation. The small horse plough and the foot plough of these districts, although probably also of cultural significance, were bound up with the rough and broken relief and with the existence here and there of patches of soil too small in size and too irregular in shape to permit the use of a large plough and of a large plough-team. In the extreme North-east, but especially in the Orkneys and Shetlands, was a peasantry largely of Norse extraction, practising partible inheritance (though with certain qualifications) and an extensive form of land utilization with only limited acreages under tillage.[4]

In post-medieval times Scottish farming exhibited the two characteristics of run-rig and of infield-outfield cultivation. Run-rig was the joint cultivation in intermixed parcels of the lands of a farm or of a small hamlet. In Strath Spey, in the late eighteenth century William Mackintosh of Balnespick sub-let three farms in this way:[5] one of 40 acres with two joint-tenants, a second of 40 acres with three joint-tenants, and a third of 50 acres with two or three joint-tenants. The farms and the number of joint-tenants, however, were usually larger than these. The system tended to be associated with a hamlet rather than with a village form of settlement. Similarly,

[1] *Chartulary of Lindores Abbey, 1195–1479*, ed. by J. Dowden (Scottish History Society), vol. XLII (1903). *Charters of Inchaffray Abbey, 1190–1609*, ed. by W. A Lindsay, J. Dowden, and J. M. Thomson (Scottish History Society), vol. LVI (1908). *Charters of the Abbey of Inchcolm*, ed. by D. E. Easson and A. Macdonald (Scottish History Society), Third Series, vol. XXXII (1938).

[2] Its beasts might be increased to ten or twelve on heavy soils and reduced to six on light soils (J. A. S. Watson, 'The Scottish Plough Team in History', *Scottish Journal of Agriculture*, vol. XIV (1931), pp. 143–5).

[3] The possibility that the bovate and the carucate were merely fiscal tenements must not be excluded.

[4] A. W. Brøgger, *Ancient Emigrants* (1929).

[5] I. F. Grant, *Everyday Life on an Old Highland Farm, 1769–82* (1924), p. 103. These acreages refer to improved land and there was muir in addition.

almost every farm on Lochtayside, according to the *Survey* of 1769, had several joint-tenants who worked the farm as a unit. Thus, to take a random sample, Ballemore had two ploughs, upper and nether, the upper being in the hands of three tenants with one-third of a plough each and the lower being in the hands of three tenants, one with half a plough and the other two with a quarter of a plough apiece.[1] The second characteristic was the infield-outfield arrangement. The arable was divided not into two or three fields, one of which was fallowed annually, but into infield and outfield, each of which was managed differently. The infield was cropped continuously without fallow rests and on it all the dung accumulated during winter stall-feeding was concentrated. The corn grown was nearly all spring-sown, bigg being sown on land freshly dunged and followed by oats–oats or oats–pease.[2] Corn cultivation was thus continuous, or nearly so. The outfield was divided into five, six, seven, or ten parts called folds, faughs, or brakes, one of which was broken up annually and cropped until the return barely repaid the amount of seed sown. It was then left to reclothe itself as best it might and used as rough pasture. The only manuring the faughs received was from the droppings of stock folded in the summer during the night and at midday on that faugh whose turn it was to be sown the following spring. Of the antiquity of the infield-outfield arrangement there is little certain evidence. Miss I. F. Grant traced it back no farther than the seventeenth century,[3] but there is a reference in a sixteenth-century charter (1541) of the Abbey of Inchcolm to 'infeyld outfeyld' and to a 'broume fald'.[4]

Continental travellers in Scotland during the sixteenth century were not impressed by the quality of the arable cultivation, but they were impressed by the abundance of stock.[5] Sample entries in thirteenth-century charters relating to Inchaffray Abbey specify 13 acres of land, that is, arable land, but 41 cows, 120 sheep, and 7 horses. Medieval Scottish agriculture, it would appear, stressed stock at least as much as crops.

It is not easy to discover the nature of the field systems of North-west England. There was land in common-field cultivation: medieval records cite land *in campo* or, to avoid any possible doubt, *in communibus campis*, and arable holdings were frequently in bovates or ox-gangs. The *St. Bees Register* lists bovates, but there is no mention of fields, the land being described as *in territorio de Bolton*, or simply

[1] *Survey of Lochtayside, 1769*, ed. by M. M. McArthur (Scottish History Society), Third Series, vol. XXVII (1936).

[2] This convention is employed throughout to indicate the succession of crops in rotation. Thus, in this instance, oats in one year was followed by pease in the next year.

[3] I. F. Grant, *Social and Economic Development of Scotland before 1603* (1930), p. 287.

[4] *Charters of the Abbey of Inchcolm*, pp. 71–2.

[5] Grant, *Social and Economic Development of Scotland*, p. 290.

in Gosford.[1] The *Furness Abbey Rental* of 1537 specified two fields of almost equal size at Bolton-in-Furness, but of the thirteen tenants only two had holdings in both fields.[2] Unless the system was in decay, the reference being post-medieval, this would not be a workable two-field system if each field was fallow every alternate year, for eleven out of the thirteen tenants would have a crop only one year in two. Liverpool had its Townfield with each man's holdings in scattered strips, but it appears to have been only a single field for agrarian purposes with sub-divisions of the dimensions of furlongs or shots for tenurial purposes.[3] Quite generally the settlement unit was small. This was especially so in the hill country where the place-name fold later became very common, but even in Cheshire the average rating per manor in the *Domesday Survey* was rather less than 1½ hides,[4] which has been taken to mean land for approximately 1½ plough-teams,[5] obviously a small agrarian unit. The inferences to be drawn from the above samples of evidence are, firstly, that the field system was on a different and much less regular pattern to that of midland England, and, secondly, that the settlement unit was frequently small with fields adjacent to it also small.[6] The highly accidented character of the relief and, even in the lowlands, the hummocky distribution of boulder clay with marsh and moss in the hollows, permitted fields for tillage to be available only in relatively small parcels, each insufficient in size to form a large field according to the requirements of the midland system. The names[7] infield and outfield were recorded in Cumberland in the reign of Elizabeth, and the name infield in the Fylde in West Lancashire in a tithe map of the early nineteenth century.[8] The references, it will be noted, are post-medieval, as in Scotland. Cultivation in the Fylde at the end of the eighteenth century, though then in severalty, was an almost continuous round of corn crops with only an occasional fallow:[9] it

[1] *The Register of the Priory of St. Bees*, ed. by J. Wilson (Surtees Society), vol. CII (1915).

[2] *Furness Abbey Coucher Book*, vol II (Chetham Society), New Series, vol. LXXVIII (1919). See also Gray, op. cit., and *A Middlewich Chartulary*, ed. by J. Varley (Chetham Society) New Series, vol CV (1941).

[3] In Cheshire reference appears to have been also to the Townfield in the singular and unless they were much shrunken remnants those Townfields recorded on the tithe maps were of quite small size even in comparison with population. D. Sylvester 'Rural Settlement in Cheshire', *Trans. Historic Society of Lancashire and Cheshire*, vol. CI (1950).

[4] *The Domesday Survey of Cheshire*, ed. by J. Tait (Chetham Society), New Series, vol. LXXV (1916). Introduction, p. 13.

[5] *Domesday Survey of Cheshire*, Introduction, p. 5. There were 500 plough-teams and 540+ hides for Cheshire as a whole, excluding uninhabited land. It cannot be assumed, of course, that each manor was invariably a separate settlement unit.

[6] In *A Middlewich Chartulary* there are references to grants of half a field (*dimidio unius campi*) which imply fields of quite small dimensions.

[7] Gray, op. cit., p. 232.

[8] I am indebted to Miss A. M. Moss for this reference.

[9] J. Holt, *General View . . . Lancaster* (1795), p. 51.

was reminiscent of the Scottish infield. In Cumberland and Westmorland[1] at this time the common practice was to crop with oats and barley continuously for nine or more years, and to leave it for almost as many years to recover by self-sown grass: this was reminiscent of the Scottish outfield. North-west England, unlike midland England, was early enclosed.

The names infield and outfield[2] are recorded, and there are also traces of the continuous cultivation and of the temporary cropping which these names respectively may be held to imply, sporadically elsewhere far removed from Scotland and Wales and in the heart of the English Plain. At West Wretham, in Breckland in East Anglia, a terrier of 1612 specifies infield and outfield. There is no certainty that the infield was cultivated continuously and of the outfield all that is known is that it was divided into seven *breks*, described as arable lands and folded with sheep each apparently once in seven years.[3] It looks as though this was similar to the system of contemporary Scotland. Traces of temporary 'outfield' cultivation have also been met with on the Yorkshire Wolds[4] and in the poor sands of the Forest District of Nottingham.[5] On the Lincoln Wolds, in the Lincoln Fens, and in the Isle of Axholme there was temporary cultivation until the land was worn out:[6] similar practices were reported on the heaths and moors of Stafford,[7] in Salop,[8] and on the Mendips.[9] There was 'every year's land' in the Vale of Gloucester,[10] and in Oxfordshire 'the more homeward or bettermost land is oftener cropped, or sometime cropped every year'.[11] It is to be noticed that the traces of 'outfield' cultivation in the English Plain refer mainly to upland wold or heath, to forest or moor; that is, to land of a special character, some of which under the agricultural practices of the day was not capable of continuous or even of frequent cropping. In any case, these references are all post-medieval.[12]

[1] J. Bailey and G. Culley, *General View . . . Cumberland* (1797), pp. 188–9; A. Pringle, *General View . . . Westmorland* (1797), pp. 270–1.

[2] Inland and outland must not be identified with infield and outfield. They had quite different meanings.

[3] J. Saltmarsh and H. C. Darby, 'The Infield-Outfield System on a Norfolk Manor', *Economic History*, vol. III (1935), p. 36.

[4] I am indebted to H. King for this reference.

[5] *Breaks* were taken up for five to six years, cropped in succession with oats (or peas)–barley–rye–oats–skegs, and then left to recover by rest (R. Lowe, *General View . . . Nottingham* (1798), p. 20).

[6] T. Stone, *General View . . . Lincoln* (1794).

[7] On the heaths of Staffordshire R. Plot described temporary tillage for up to five years (rye–barley–peas–oats–oats), after which the land was 'thrown open to the commons again' (R. Plot, *Natural History of Staffordshire* (1686), p. 343).

[8] J. Bishton, *General View . . . Salop* (1794).

[9] J. Billingsley, *General View . . . Somerset* (1794).

[10] G. Turner, *General View . . . Gloucester* (1794).

[11] R. Davis, *General View . . . Oxford* (1794).

[12] The name *breche* (O.E. bræc and M.E. breche) is common in many Midland counties and is noted in the reports of the English Place-Name Society on the counties of Northampton, Buckingham, Bedford, Huntingdon, Warwick,

It is thus clear that there was great variety in systems of cultivation and in relative emphasis on crops and stock in different parts of medieval Britain. It is tempting to read a cultural provenance into these, but, though there are traces of this in some of the tenurial features, cultural and agricultural distributions do not always coincide. The well-defined two- and three-field system, often assumed to be the *English* system, prevailed in an area much less than the area of the English settlement. The systems of west and north Britain, in their various forms, which have been labelled *Celtic* on the grounds that they were practised in those parts of Britain not involved in the English settlement, did not coincide either with the area of Celtic survivals. There is rather more justification to read a cultural provenance into the Kentish system, but the cultural relationships of the East Anglian are as baffling as those of the rest. The truth of the matter does not seem to lie along these paths. The rigid two- and three-field system, on the one hand, and the flexible temporary cultivation system on the other, were alternative methods of solving the farmers' problem of maintaining the fertility of the land. They may, as Dr. Orwin argues, be arranged in order of more primitive and more advanced means to this end,[1] but they also show signs of some relationship with the regional environments of the country. This is the justification for a somewhat prolonged discussion and quotation of evidence.

Nasse pointed out that the 'field-grass husbandry',[2] as he described the temporary cultivation, was suited to areas having a considerable rainfall where, during the years of recovery after exhaustion from continuous cropping, a tolerably good grass sward could naturally develop. This line of argument is capable of extension and further application. In western Britain, where this system was common, grass-fed beasts were as important as corn, and at its best it was a form of convertible husbandry. The Scottish infield-outfield was,

Worcester, Surrey, Hertford, Essex, Cambridge, Middlesex, Nottingham and Wiltshire. The interpretation of the name there given is 'land broken up for tillage', but this does not necessarily imply land broken up for *temporary* tillage and then abandoned. It would be incorrect to assume that where the name appears an 'outfield' type of cultivation is implied. Similarly, Bishop finds the term *brek* to be a synonym for *assart* in Central and East Yorkshire in the thirteenth century. In districts with Norse place-names the modern *breck* is usually derived from O.N. *brekka*, a slope. Thus Breck Shutes in the Liverpool Townfield were on the slope of Everton Hill. Breck is a common place-name element in West Lancashire. Homans (op. cit., p. 84) regards *intake* as descriptive of land temporarily broken up for tillage, though he admits that some of these intakes later became permanently arable. In the North of England the term *intake* has been customarily applied to land permanently reclaimed from the waste.

[1] The more primitive is the temporary cultivation. In his book *The Open Fields*, a reference to the siting of strip-holdings in Cornwall prompts the comment, 'This is further support for the theory which suggests topographical and technical, rather than ethnic, limitations to the evolution of the Open Fields', p. 65.

[2] E. Nasse, *On the Agricultural Community of the Middle Ages* (1871). Trans. by H. A. Ouvry.

perhaps, a specialized practice which allowed full use to be made of the best crop land. In the lowlands of the English Plain, on the other hand, where the climate was drier and more suited to corn, it was at once more profitable to have a greater acreage under corn and more difficult to grow a good grass sward. The two- and the three-field system was primarily a corn-growing system, and the one-year fallow was insufficient to grow a tolerably good grass sward. If the ideas put forward by Nasse may thus be extended, the two systems may be interpreted as adaptations to the conditions of their respective climatic environments. The argument may be taken further. The traces of 'outfield' cultivation within the English Plain are mainly in areas of poor soil, and Marc Bloch noted that in France 'dans les pays de sol pauvre, l'Ardenne, les Vosges, les zones granitiques ou schisteuses de l'Ouest, pratiquaient sur toute leur étendue la culture temporaire'.[1] Finally, it may be asserted that the two- and three-field system with its requirement of large fields of more or less uniform soil was suited to the English Plain, but not to the accidented surface of the west and north, to whose varied relief was added the local variation of soil as a result, directly or indirectly, of glaciation. If these arguments are valid, the variation in medieval methods of land utilization as between the two- and three-field system and those of the west and north was related to regional differences in physical environment. The effect of physical environment on the distinctive qualities of medieval Kentish and East Anglian farming is not so clear, unless it can be argued that the continuous cultivation of some of Kent was related to the fertility of its soil—it was the 'garden' of England—and that the sheep-folding of East Anglia was related to its dry soils, naturally 'sound' for sheep liable to be infested with the liver fluke on damp ground. It may be, as Bloch argues for France, that these cultivation systems were related also to particular forms of plough.[2] And it may be that they were associated with particular forms of settlement, as Meitzen argues for North-west Europe as a whole.[3] Some investigations along these lines have been collected by the Commission de l'Habitat Rural of the Union Géographique Internationale.

There was no more uniformity in the particular grains grown than there was in methods of land utilization. The grains were winter corn, wheat and rye, and spring corn, barley, bigg, and oats, together with pease and beans.[4] Winter corn and spring corn were both

[1] M. Bloch, *Les Caractères Originaux de l'Histoire Rurale Française* (1931), p. 27.

[2] Bloch, op. cit., pp. 51–7. Also J. B. P. Karslake, *The Antiquaries Journal* (1933).

[3] A. Meitzen, *Siedelung und Agrarwesen de Westgermanen und Ostgermanen* (1895), 3 vols.

[4] They were not always sown separately. Wheat and rye were often mixed, and this was maslin or mancorn (W. J. Ashley, *The Bread of Our Forefathers* (1928)); barley and oats were mixed as in the South-west Peninsula to-day. Whether the pure or the mixed grain was sown depended partly on the season, for, if sowing was late, rye might be sown along with wheat or even instead of it, and partly on

grown throughout the English Plain and in western lowlands such as Pembroke in South-west Wales. But there was little or no winter corn in upland Wales,[1] in the higher Pennine uplands,[2] and in Scotland (except the South-east). In upland Wales, though some wheat was grown, it was spring wheat sown in late March–early April.[3] In these uplands the chief corn crops were oats and bigg, the northern form of barley. In this, the effect of the lower temperatures and shorter growing season of the uplands can be easily discerned. In South Wales the distinction between those communities which grew winter corn and those which did not was heightened by the cultural distinction between English and Welsh. Within the areas climatically suitable for winter corn, the choice lay between wheat and rye. The effect of the space-relations of Britain at the terminus of the Mediterranean–Atlantic and of the North European Plain routes alike is evident, for wheat is dominant in the Mediterranean and France, rye in the North European Plain. It is very difficult to determine the geographical distribution of wheat and rye respectively in medieval Britain.[4] There is no doubt that wheat was gradually increasing at the expense of rye even in the Middle Ages; it indicated the growth of capitalist farming and the modification of the medieval economy.[5] There is some evidence, however, to indicate that particular areas did concentrate on particular crops. In the Hundred of Blackbourne in West Suffolk tax assessments of 1283 show no wheat but much rye in the westernmost parishes, much wheat but little rye in the easternmost.[6] The west part of the hundred has the light poor soils of Breckland, the east part the stiffer richer soils of High Suffolk (*see* pp. 187–8 below). An examination by Dr. Pelham of a Kent account roll of 1297 giving the hundreds from which grain was supplied for an expedition to Gascony affords another

the policy of the farmer, for rye often succeeded in a year when wheat failed and the sowing of wheat and rye together was a form of medieval insurance. Wheat, rye, barley, and oats were all used for bread and in times of scarcity pease and beans would be mixed in as well.

[1] Rees, op. cit., pp. 187–8.

[2] G. H. Tupling, *The Economic History of Rossendale* (Chetham Society), vol. LXXXVI (1927), p. 40.

[3] Owen, op. cit., pp. 60–1.

[4] Detailed records refer mainly to demesne farming which was then devoted (in part) to the growing of corn for sale and for this purpose wheat was the grain chiefly in demand. Wheaten bread was eaten by the upper classes, rye bread by the lower. The peasant might grow rye for his own household, but it was not sold extensively and was not therefore favoured by the capitalist farmer. Hence, so Ashley argues (op. cit., pp. 83–94), the fact that wheat figures much more prominently than rye in Thorold Rogers's material (J. E. Thorold Rogers, *A History of Agriculture and Prices in England*, vols. I and II (1866)) does not prove that wheat was grown more extensively than rye, for his material was drawn chiefly from bailiffs' accounts.

[5] Ashley, op. cit., p. 137. It also registers improved farming by liming and draining.

[6] E. Powell. *A Suffolk Hundred in the Year 1283* (1910). It would be possible by working through the detailed acreage and production statistics of the manors of the Bishopric of Winchester to give many more examples.

illustration that this variation of grain grown sometimes, at any rate, coincided with differences of soil, if it be assumed that contributions from each area accorded in kind with the local production. He finds that the chalk loams, particularly those of East Kent and the Isle of Thanet, contributed mainly wheat and barley, while the forest soils of the Weald and the marsh soils of Romney contributed mainly oats with only a little wheat.[1]

Finally, there were regional variations in stock farming. It has already been pointed out that in the uplands of the west and north (and in some of the western lowlands as well) pastoralism rather than corn-growing dominated the agricultural geography. What corn was grown was mainly, if not invariably, spring corn. The better land, though under corn in spring and summer, was thus available for stock grazing in winter when pasture was scarce. In this sense the choice of spring corn rather than winter corn was an adaptation to pastoralism. The stock kept included both cattle and sheep. Sheep were fewer than to-day. It is true that they figured numerically rather prominently in the *Black Book of St. David's*, for example, yet if they be equated with cattle at the rate of ten head of sheep to one head of cattle[2] (the ratio there adopted in measuring pasture values) they become roughly equal in importance. Sheep were kept as much for their milk[3] as for their wool, a practice which remained in the Highlands and Southern Uplands of Scotland[4] until the end of the eighteenth century and in upland Wales until the end of the nineteenth century.[5] The milk was made into cheese in which form summer-produced food could be stored for winter use. The keeping of sheep primarily for wool was a late development, and its arrival marked the emergence of capitalist farming. In some upland districts cattle alone were kept. Many parts of the Pennines were managed as vaccaries or cattle-breeding farms. In Blackburnshire, on the slopes of Rossendale, Pendle and Boulsworth Hills, there were in 1296 28 and in 1305 29 vaccaries with 2,423 and 2,397 head of cattle respectively. There were similar breeding farms in adjacent parts of the West Riding. When they reached maturity, the beasts were sold into the lowlands, the young oxen for the plough and the heifers for the dairy. Cattle were similarly exported from North Wales into the Cheshire Plain.

[1] R. A. Pelham, 'Grain Growing in Kent in the Thirteenth Century', *Empire Journal Experimental Agriculture* (1933), pp. 82–4.

[2] The same proportions of cattle to sheep were employed in the stints of common pasture at Apsley Guise in Bedfordshire in 1633–4. The *Survey of Lochtayside, 1769*, in Scotland equated five sheep to one cow, ignoring followers in each instance.

[3] *Walter of Henley's Husbandry*, p. 27. Ten sheep were reckoned to produce the same quantity of cheese or butter as one cow.

[4] In the English Plain, sheep milking, though common in the Middle Ages, died out earlier. In parts of the English Plain, in the Cotswolds and Herefordshire Ryelands at least, sheep were 'cotted' or housed and fed under cover in winter.

[5] J. H. Clapham, *An Economic History of Modern Britain: Free Trade and Steel* (1932), p. 277.

It appears to have been on the abbey lands that sheep-farming for wool first developed on a large scale. Pegalotti's list (*c.* 1315) of houses supplying wool to Flemish and Italian merchants shows that

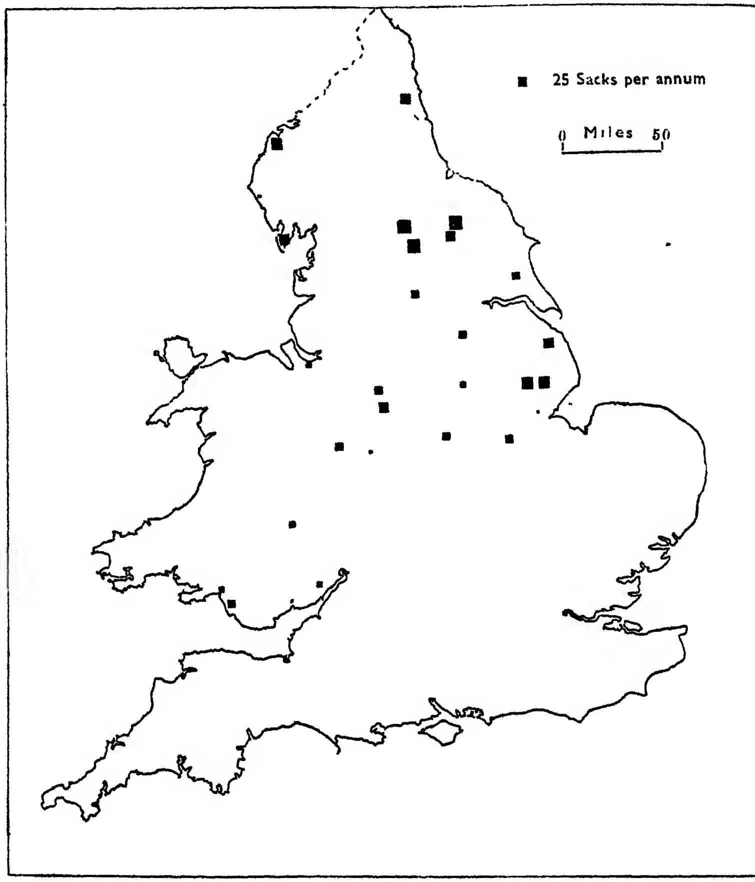


Fig. 2

MONASTIC HOUSES SUPPLYING WOOL TO FLEMISH AND ITALIAN MERCHANTS

Map constructed from Pegalotti's list, dated *c.* 1315, printed in W. Cunningham, *Growth of English Industry and Commerce* (1929 Ed.). The symbols vary in size in proportion to the quantities supplied.

the largest producers lay on the western fringes of the English Plain, especially those in relatively remote districts (see Fig. 2). But numbers of sheep increased at a later date in South Wales and in the manors of the Bishopric of Winchester, and Thorold Rogers quotes wool prices for almost every county in the English Plain. Sheep-farming thus became widespread. Whether wool sheep were

kept mainly on particular types of land is not altogether clear, but there is some reason to suppose that sheep were more plentiful on the South Downs than in the Weald, on the Mountain Limestone than on the Millstone Grit. They were kept frequently on heaths and downs and almost every writer in the sixteenth century ascribed the finest wool to such sheep.[1]

The yield from farm stock was low. They were small beasts. Thorold Rogers notes that in the sixteenth century oxen bought for victualling the Navy weighed no more than 4 cwt.,[2] and the average sheep fleece weighed little more than 1 lb. in South Wales,[3] but nearer 2 lb. was probably the general average.[4] The yield of milk by the dairy cow was low, a wey (224 lb.) of cheese[5] being made from each beast during each season lasting from Easter to Michaelmas, and she was not expected to yield much milk outside this period.[6] This gives a lactation little more than 6 months long, as compared with the 10½ months, which is the average at the present day.[7] These low yields reflect the lack of good pasture and the scarcity of winter feed. Meadow hay was valuable and fed sparingly and many beasts had necessarily to be killed in the autumn because there was no winter feed for them.

II

THE NEW HUSBANDRY

The agricultural geography of medieval times was in process of gradual modification during the fifteenth, sixteenth, and seventeenth centuries, but it was not *replaced* until the Agrarian Revolution, which, as will appear, was a geographical as well as a tenurial and technical revolution. It would be interesting to trace the progress of change, but limitations of space will not permit. The upshot was a very different geographical distribution of farming types, almost exactly the reverse of the distribution pattern of medieval times. The foundations of this new distribution pattern had been laid in the seventeenth century, and it did not finally take shape until the nineteenth century, but its outlines were already established by the end of the eighteenth.

[1] There is modern evidence to show that a sheep fed on a deficient diet gives a finer and shorter fleece than if fed on an adequate diet (W. C. Miller, *Empire Journal Experimental Agriculture* (1933), p. 173).

[2] Rogers, op. cit., vol. 1, p. 328. This may have been carcase weight and not live weight.

[3] Rees, op. cit., p. 197.

[4] Rogers, op. cit., vol. 1, p. 53.

[5] This was only on good pasture. Walter of Henley notes a yield in addition to the wey of cheese, of half a gallon of butter a fortnight, but it was probably whey butter. This implies a yield of milk in the season of approximately 224 gallons.

[6] Lamond, op. cit., pp. 27 and 77.

[7] H. G. Sanders, 'Variations in Milk Yield and their Elimination', *Journal Agricultural Science* (1927 and 1928).

The new technique of farming involved both arable and stock. The improvement of both crops and beasts was intimately related. The New Husbandry, the new arable technique, was gradually formulated as the eighteenth century wore on. In order to appreciate its significance in effecting the revolution in the distribution of arable farming, it is necessary to consider its main characteristics. The first was the principle of cultivation embodied in Jethro Tull's horse-hoeing husbandry—constant tillage of the soil, not only before seeding, but when the crop was growing, in order to destroy weeds which robbed the soil of nutriment and competed with the growing crop. With seed sown broadcast, hand-hoeing of a growing crop is difficult, but horse-hoeing impossible. The complementary aspect of Tull's constant tillage was, therefore, the sowing of seed in drills, in straight lines sufficiently far apart to permit a horse-drawn hoe to cultivate the rows between them.[1] He himself practised horse-hoeing with wheat, but this involved very thin sowing, and it was with roots that the method was most successful. Constant tillage is easier in light than in heavy soils, for these cannot be worked in very wet or in very dry weather, and horse-hoeing husbandry was therefore better adapted to light than to heavy soils. This was of considerable geographical significance, as will appear later. During the eighteenth century an improved plough was introduced. The Rotherham plough, patented in 1730, 'shows a great advance in the improved form of its frame and had a profound effect on plough design in this country'.[2] Not only was ploughing more effectively done, but the easier traction permitted a given number of animals (and of ploughmen) to do more work and made constant tillage correspondingly more easy. The smaller plough-team also rendered co-operative ploughing largely unnecessary except for the very small copyholders.

The second characteristic of the New Husbandry was the field cultivation, as an integral part of the rotation, of the new crops introduced on the farm in the seventeenth century—turnips, potatoes, temporary grasses. The crops under medieval systems of farming were mostly 'white' crops, grain of various kinds. These all exhausted the soil and a fallow was necessary to permit the land to recuperate. The stirring of the soil during the summer fallow encouraged nitrogen accumulation, but summer cultivation of the fallow does not in practice seem to have been very clean, and the summer fallow

[1] Horse-hoeing husbandry was the description which Tull gave to his methods, but it was often known to contemporaries as the drill husbandry, a description which Cobbett later also employed (W. Cobbett, *Rural Rides, 1821–32*, ed. of 1908, vol. II, p. 184) Tull invented and used a drill which, though possibly not the first of its kind, was the first to achieve practical success. The drill effected a very considerable saving in the amount of seed sown.

[2] A. J. Spencer and J. B. Passmore, *Agricultural Implements and Machinery* (1930).

was regarded chiefly as pasture for stock. The only non-grains cultivated in medieval times were pulses, pease and beans, which were sometimes substituted for the spring-sown corn. Though sometimes reckoned as 'white' crops, pulses 'tend to increase the soil reserves of nitrogen',[1] and in this sense are recuperative and not exhaustive crops. The medieval farmer's preoccupation was the growing of bread corn (and drink corn) and, as pulses were inferior in this respect, spring corn was favoured in their stead.[2] Of the new crops, seed grasses served the same purpose as pulses in accumulating nitrogen when the grass sward was ploughed under and decomposed. Moreover, a grass seeds mixture, if suitably selected, gives a heavy yield of hay, considerably heavier in its first and second years than from a permanent grass sward. One of the greatest problems of the medieval farmer, one which he never solved, was the provision of winter food for stock. The sixteenth century saw no improvement in this respect, but seeds hay, which, if a one-year sward, could usually be cut twice, helped considerably in its solution.[3] The significance of the roots, turnips and potatoes, was different. These are cleaning crops or, as they were described in the eighteenth century, fallow crops. Being drilled or set in rows, they permitted constant tillage between them during the summer: the land was thoroughly aerated and thoroughly weeded. They served the same purpose as a frequently stirred bare fallow and there was a crop in addition. Roots thus eliminated the need of fallow on land where potato or turnip cultivation was possible. The soil could now be cropped continuously without fear of exhaustion. This form of husbandry with turnips instead of fallow was invariably described at the end of the eighteenth century as the turnip husbandry. Neither crop, however, was suited to heavy land: mangolds, which are, were not introduced until nearly the end of the eighteenth century. Potatoes were largely human food, but field turnips were food for stock and, together with seeds hay from the temporary grass, provided that winter food hitherto lacking. Temporary grass and roots were incorporated into a rotation which, developed in Norfolk, came to be known as the Norfolk system. Winter corn was sown in autumn or early winter on a ploughed-in grass sward; in the second year, the soil was well tilled in the spring and early summer and turnips were sown in June; in the third, barley was sown in spring and a few weeks afterwards grass seeds for the following, the fourth, year.

[1] J. A. S. Watson and J. A. More, *Agriculture. The Science and Practice of British Farming* (1933), p. 277.

[2] Orwin, however, remarks: 'It would be more correct, instead of talking of the "bread corn" and the "drink corn", to speak of the "bread field" and the "fodder field"' (Orwin, op. cit., p. 168).

[3] When a one-year sward was the object, the seeds sown in the eighteenth century were mainly red clover and trefoil. Lucerne and sanfoin, on the other hand, are deep-rooted grasses and were sown on land intended to be in grass for six to seven years.

This rotation incorporated an important principle, the alternation of a recuperative with an exhaustive crop. No two corn crops followed each other, temporary grass followed the spring corn and roots the winter corn. Thus was continuous cultivation practised and the fertility of the soil maintained.[1] The aggregate production from a given unit of land was increased.

The third characteristic of the New Husbandry was the close association of crops and stock. Nathaniel Kent described the similar rotation of Flanders as 'an alternate crop for man and beast'.[2] Seeds hay and turnips provided an abundance of winter food.[3] Turnips were either lifted or fed to stock on the ground. When intended for cattle feeding, they were usually fed in the stall or yard; when for sheep feeding, the crop was usually fed off to sheep folded on the turnip field. Bullocks fattening on turnips, straw, and hay yielded vast quantities of manure which were carted back on to the land to return fertility to it. Bullock feeding, unlike the grazing of dairy cows or ewes in milk, takes relatively little out of the land if manure is thus returned. Where oil-cake was fed—Coke of Holkham is reported to have introduced it into Norfolk at the end of the eighteenth century—the manurial residue was a net gain to the soil. Sheep were folded on the turnip field and the fold was moved until the whole crop was eaten: folding enabled the land to be systematically and evenly manured and, on light land, the treading of the sheep consolidated the soil.[4] Stock, therefore, not only enabled a profitable use to be made of hay and roots, but, by manurial residues, the fertility of the land was maintained and, in some cases, positively increased.

Closely associated with the New Husbandry and its provision of more and better stock food was an improved breeding of stock. This

[1] Subsequent experience made it clear that continuous cropping was possible only with heavy manuring and that land became clover-sick if sown regularly every fourth year (J. Caird, *English Agriculture in 1850–1* (1852), pp. 501–3). Modifications of the strict four-course developed in consequence, though the principle of this alternate husbandry, the alternation of exhaustive with recuperative crops, remained.

[2] N. Kent, *General View . . . Norfolk* (1796).

[3] Where the farm consisted very largely of arable, as was common in East Anglia, there was little summer food available, and the bullocks and the sheep were bought in at the fall of the year. 'East Norfolk farms,' says Marshall, writing in 1787, 'are in the months of July, August, and September as free from sheep as elephants.' Many bullocks, however, were grazed in summer on the marshes about the Broads.

[4] It was not inappropriate that the New Husbandry should be associated so closely with East Anglia, for medieval East Anglia had given special grazing privileges to sheep in the custom of fold-courses. Sheep-folding on the fallow was not, however, peculiar to East Anglia. Best records it in the East Riding in the seventeenth century (H. Best, *Rural Economy in Yorkshire in 1641*, p. 17), Plot in Oxford and Stafford, and the county reports record it at the end of the eighteenth century in Lincoln and Gloucester, *inter alia*. Defoe reported it on the Central Downlands as a new method of husbandry contributing to a great increase in fertility (D. Defoe, *Tour thro' the Whole Island of Gt. Britain*, ed. G. D. H. Cole (1927), vol. 1, pp. 187, 285–6).

was not possible until seeds, hay and turnips had increased the supply of winter fodder. Hitherto such stock as could not feed itself in winter on the fallow or the commons was slaughtered in the fall of the year. The plough-oxen and horses and some breeding stock were given what hay was available, but there was little left for growing beasts. Tusser's descriptions make clear the poor condition of stock at the end of winter in the sixteenth century.[1] Any careful breeding and rearing was impossible. The founder of modern stock-breeding was Robert Bakewell, whose work began in the 'forties of the eighteenth century. It is very significant that he made full use of the turnip husbandry and that he was as much an expert in irrigating meadows[2] as in selecting stock from which to breed. The improvement of fodder and the improvement of stock went on hand in hand. His object in selecting breeding stock was not the perpetuation of 'fancy points', but, to use Youatt's words, 'the greatest propensity to fatten, . . . the largest proportion of valuable meat, and the smallest quantity of bone and offal'.[3] His greatest success was with Leicester sheep, the Dishley Leicester, as it was known to contemporaries. It was an economical feeder on good lowland grass or when folded on arable crops, and in Bakewell's hands it developed into a very effective mutton sheep, but it was not suited to poor land. Sheep had previously been kept almost entirely for wool (and milk) and the rapid extension of the improved Leicester, a mutton and not a wool sheep, in the latter part of the eighteenth century indicated to what extent increased food production had become a prime object of British farming. His experiments with Longhorn cattle were not quite so successful: he produced a better beef animal, but at the sacrifice of milk production. Bakewell's work was quickly followed by others, for once the improved methods of breeding had achieved success they came to be applied later to the numerous regional breeds of Britain, each of which developed during the course of the nineteenth century some special excellence or some special adaptation to the qualities of the local environment. The production of food from British stock was greatly increased. Sir John Sinclair reported to a Parliamentary Committee in 1795 that the average weight of beeves at Smithfield in 1710 was 370 lb., in 1795 800 lb.; of sheep in 1710, 28 lb., in 1795, 80 lb.[4] These weights cannot be accepted without reserve, and if the 1795 figures represented live weights and the 1710 carcass weights dressed for the butcher, the increase would become of more reasonable dimensions.

[1] 'From Christmas, till May be well entered in,
Some cattle waxe faint, and looke poorely and thin.'

T. Tusser, *Five Hundred Pointes of Good Husbandrie*, ed. of 1580 reprinted by English Dialect Society (1878), p. 142.

[2] Bakewell's methods of watering meadows are described by W. Marshall, *The Rural Economy of the Midland Counties* (1796).

[3] W. Youatt, *Sheep* (1837), p. 314.

[4] Quoted by Lord Ernle, *English Farming Past and Present* (1932), p. 188.

At the very end of the eighteenth century the first Board of Agriculture was founded, with Arthur Young as its secretary, and commissioners were appointed to report on the farming of each county of Great Britain. These reports[1] are a mine of information, and it is possible with their aid to reconstruct the agricultural geography of the time. For the first time it is possible to make a systematic survey of the whole country. Contemporary with these county reports was a series of surveys made by William Marshall, first of counties, Norfolk and Yorkshire, and later of large regions of England, the West of England, the Midlands, the West Central, the Southern. The object of these single-handed surveys was the delineation of the regional agriculture of England within the natural framework of the land as distinct from the artificial framework of the counties. Marshall has been hailed, with some truth, as the founder of modern agricultural geography.

The New Husbandry had made considerable progress by the end of the eighteenth century, but it was often practised only in part and not in its entirety. The turnip husbandry had spread widely and the sowing of clover more widely still, but turnips were very frequently sown broadcast, and, if hoed at all, only by hand.[2] The new crops, it may be inferred, were adopted more readily than the improved methods of tillage. The turnip husbandry was found down the entire eastern side of England from Northumberland to Kent, but only on light and medium soils and not on heavy.[3] In Marshall's Midland Department, a region[4] of relatively strong soils and 'a grassland country', turnips were not common except on light soils, and it was admitted that their cultivation presented 'difficulties . . . on strong retentive land'.[5] The turnip husbandry was not practised extensively in North-west England or in the South-west Peninsula, and only to a very small extent in Wales. In some Welsh counties field turnips were apparently unknown, and in others, as Pembroke,[6] only lately introduced. All the reporters were convinced of the value of the turnip husbandry for light soils. Most were also of the opinion that, however excellent the turnip husbandry was for light soils, it was not suited to deep clays and that on these soils an occasional bare fallow was still essential to clean the land. The sowing of clover and rye grass was more widespread, both as to soil and as to region,

[1] The earliest were issued in 1794 in quarto for comments and additions. In most cases a revised report in octavo was issued subsequently.

[2] The Cornwall report, for example, noted that turnips were grown only by the larger farmers and that even they cultivated them badly, neither drilling nor hoeing (Fraser, op. cit., p. 43).

[3] In Nottingham, for example, turnips were grown on the soils of the Forest District, but not on the clays of the Vale of Belvoir (R. Lowe, op. cit., pp. 10 and 28).

[4] Leicester, Rutland, Warwick, together with South Derby, South Nottingham, East Stafford, and North Northampton.

[5] W. Marshall, *Rural Economy of the Midland Counties*, vol. 1 (1796), pp. 203–6.

[6] C. Hassall, *General View . . . Pembroke* (1794), p. 17.

than the turnip husbandry. It was suited to heavy as well as to light soils and to western as well as to eastern districts. In the west, where the long ley was common, the better farmers sowed down clover as a preparation for it, although the poorer farmers continued to sow seeds taken at random from the hayrick if, indeed, they sowed grass seeds at all. Many allowed their land to seed itself. The western districts adopted even the clover husbandry less extensively than the eastern; it was not because the clover husbandry was unsuited to their soil and climate, but because they were still culturally remote and their farming methods relatively old-fashioned.[1] The value of the clover and rye grass husbandry was very substantial when properly practised. In Cheshire it provided spring grazing a week or ten days earlier than any other pasture, and was ready to be cut for hay by mid-June, at least a month earlier than the natural meadow.[2] In Northumberland old natural meadow usually gave 1–1½ tons of hay per acre, clover and rye grass 2 tons.[3] Arthur Young placed clover after turnips as the greatest of 'modern improvements'.[4] Like turnips, potatoes were mainly suited to light and medium soils, but, unlike turnips, they were to be found mainly in western districts—in Lancashire, Cheshire, Cumberland, Somerset, West Cornwall, to give a few examples. In most of these districts they had become the staple diet of the poor. In Wales they had only recently been introduced and were absent in some counties: their cultivation was, however, increasing and taking the place of potatoes imported from Ireland.[5] Potatoes were not, however, confined to western districts. They were grown in Northumberland and in the West and North Ridings, and they had become an export crop from the Humber marshes,[6] an important potato district to-day, but there is no mention of them at all in the Fens of the Holland division of Lincoln. The geographical distribution of potato cultivation, like that of turnips and clover, was to change very considerably during the course of the nineteenth century.

In previous centuries wheat had hitherto been sown to only a limited extent in the north-western parts of England and on the edges of many upland areas. This was true of the sixteenth century as well as of the Middle Ages. The county reports give evidence of expanding wheat cultivation in several areas in the late eighteenth century. In Cumberland it was reported, 'Wheat is a modern production here; a general opinion used to prevail, that wheat

[1] Artificial handicaps were also imposed on its practice, for in Buckingham many leases forbade the sowing of clover or of any green crop (W. James and J. Malcolm, *General View . . . Buckingham* (1794), p. 22).

[2] H. Holland, *General View . . . Cheshire* (1808), p. 184.

[3] J. Bailey and G. Culley, *General View . . . Northumberland* (1797), pp. 96–101.

[4] A. Young, *General View . . . Suffolk* (1797) p. 83.

[5] G. Kay, *General View . . . Anglesey* (1794), p. 14.

[6] Rennie, Brown, and Sherriff, *General View . . . West Riding* (1793) p. 99; Stone, op. cit.

could not be grown in many parts of this county'.[1] It was into the Carlisle Plain and the West Cumberland coastlands that wheat had been introduced. In Lancashire wheat was now grown in the south-west, the Fylde, and Low Furness, but not on the higher land towards the moors. Upper Ryedale, in North-east Yorkshire, was formerly supplied with wheat grown in Cleveland, but this import had ceased and wheat was then being sent from Upper Ryedale to the manufacturing districts of the West Riding.[2] In Flintshire wheat was taking the place of rye and barley.[3] This extension was, in a sense, into areas climatically marginal to wheat, encouraged by high prices and an increasing demand, but it also reflected a modification of the spring corn complex of many of these districts, associated with their pastoralism and convertible husbandry.[4]

At the end of the eighteenth century there was considerable variation of rotation, and this usually coincided with differences of soil and climate. The Norfolk system was practised on light soils in the eastern drier half of England: it was associated with heavy winter feeding of stock whose manure was essential for the maintenance of land fertility. On the clay soils of the English Plain, where the turnip husbandry was impossible, either the traditional common-field cultivation was retained or corn was alternated with clover and beans. In western districts, with a moist climate naturally favouring grass, the long ley was common, either in its unimproved form of a rest for exhausted land or else associated with improved arable rotations which were gradually being adopted. This summary of the distribution of crop rotations has been drawn from the evidence of the county *General Views.*

As a result of improved cultivation the yield of corn had risen considerably. Particulars of yield for wheat, barley, rye, and oats have been abstracted from the county reports, and these are set out in Table II.[5] In the mid-seventeenth century Hartlib reported a six- to eight-fold increase as a good crop of wheat, and King, at the end of the century, a five-fold increase. If seeding was at the rate of 2–2½ bushels per acre, this would give crops of 12–20 and 10–12½ bushels per acre respectively. The returns in Table II indicate that the yield of wheat at the end of the eighteenth century was

[1] J. Bailey and G. Culley, *General View . . . Cumberland* (1797), p. 190.

[2] Tuke, *General View . . . North Riding* (1794), p. 35.

[3] G. Kay, *General View . . . Flint* (1794), p. 10.

[4] In 1758 Charles Smith estimated that more ate oats and barley bread than wheat bread in North England and Wales, but that few ate other than wheat bread in the English Plain. Quoted by J. Percival, *Wheat in Great Britain* (1943).

[5] The list does not pretend to be complete, but samples are given of different parts of the country. The figures must be regarded as only very approximate. On account of the statistical difficulties involved, no attempt has been made to calculate a figure for the country as a whole. One such difficulty is the uncertainty as to whether the statute acre or a local acre was employed, another is the uncertainty as to the weight of the bushel in each case.

probably between 20 and 25 bushels per acre.[1] The increase was substantial. In 1771, Arthur Young estimated the yield of wheat to be 23 bushels per acre. Bennett is of the opinion that Arthur Young's estimate was too high for the mid-eighteenth century,[2] but it accords for the end of the century with the estimates in the county reports.

TABLE II

Yield of Grain per Acre at the end of the eighteenth century

	In bushels per acre			
	Wheat	Barley	Oats	Rye
Cumberland	16–30	21	15–40	—
Lancashire	24	30	40	—
Cheshire	20	25	30	—
Stafford	25	30	30–40	—
Worcester	15–20	25–45	—	—
Gloucester	20–24	20–25	24	—
Carnarvon	32	28	32	—
Montgomery	27½	29	34	25
Northumberland	24–30	30–60	20–60	20–30
West Riding	20–30	30–44	48–70	—
Nottingham	16–32	24–56	32–56	24–32
Northampton	26	34	36–40	—
Rutland	24–32	28–36	36–64	—
Cambridge	23	36	26	20
Norfolk	24	32	—	—
Suffolk	22	28	32–36	16
Essex	24	33	36	20
Kent	22	26	12–56	—

Compiled from the county reports to the Board of Agriculture, 1794 onwards.

Although it is not possible to use Table II[3] to indicate regional differences of yield owing to innumerable statistical difficulties, it is possible in certain cases to discover variations between small areas within individual counties, for it may be presumed that within a single county there was a more uniform statistical presentation. In East Norfolk the yield of wheat was 48 bushels per acre, but in the 'very light parts of the county', that is, in West Norfolk, only 16 bushels per acre.[4] In Suffolk the yield of wheat varied from 32 to 40 bushels on the best soils to 12 bushels on poor sands, which were really rye and not wheat soils.[5] In Kent the yield of oats was sometimes as low as 12 bushels per acre on poor down, but on good land

[1] It is not possible to compare the yield in one county with that in another at all closely, as there were wide differences in methods of estimation, varying from detailed estimates for the districts or parishes, as in Essex and Cambridge respectively, to very general estimates for the county as a whole, in addition to differences in size of acre and weight of bushel.

[2] Bennett, op. cit., pp. 25–6.

[3] See footnotes on this and previous pages.

[4] Kent, op. cit., p. 56.

[5] Young, op. cit., p. 53.

it was up to 56 bushels per acre.[1] In Essex the alluvial lands along the coast gave as high as 30 bushels of wheat per acre and 40 bushels of oats, but the chalk soils in North-west Essex gave only 20 bushels of wheat and 24 bushels of oats.

During the course of the seventeenth century, as the topographers pointed out, many of the heavy clay soils were beginning to develop into grass districts. The process was continued during the eighteenth century, and it was not to be finally completed until the close of the nineteenth. At the end of the eighteenth century much clayland arable remained, but Arthur Young admitted that the arable management of heavy soils was not as well understood as that of light soils. The New Husbandry, with its emphasis on turnips and constant tillage, was essentially a light land system. The clay which remained in arable often followed traditional medieval rotations whether it was enclosed land or common field, and it is not surprising that it immediately became more profitable when laid down to grass, provided it was laid down with an appropriate seeds mixture and was not allowed to tumble down unaided. Nathaniel Kent, after writing of the improvements in productivity after the adoption of turnips and seeds, goes on 'to say nothing of the wonderful improvements which sometimes result from a loam or clay; which will, when well laid down, often become of twice the permanent value in pasture, than ever it would as ploughed land. Most striking effects of this sort are to be seen in Leicestershire, Northamptonshire, and other midland counties'.[2] It is possible from the accounts given in the county reports to construct in outline the geographical distribution and character of grass farming at the end of the eighteenth century. It was clearly becoming identified with clay, as arable was with light, soils.

The standard of grass husbandry was admittedly low in East Anglia and Kent, the very areas where the arable New Husbandry was most successfully practised. 'Upon the same farms,' says Arthur Young, writing of Suffolk, 'where almost every effort is made upon the arable, the grass is nearly, or quite neglected. . . . Our sister county of Norfolk is, if possible, yet worse in this respect.'[3] Similarly, Boys reports that 'the hay-meadows of Kent are much inferior to those of many other counties'.[4] Marshall confirms the poor standard of grassland management.[5] The reason for the neglect was partly environmental, for the dry climate (and largely light soils) of these districts were unsuited to grass, and it was partly due to the concentration of attention on the arable, here the main object of husbandry.

[1] J. Boys, *General View . . . Kent* (1796), pp. 87–90.
[2] Kent, op. cit., pp. 73–4.
[3] Young, op. cit., p. 138.
[4] Boys, op. cit., p. 105.
[5] W. Marshall, *The Rural Economy of the Southern Counties*, vol. 1 (1798), pp. 163–6.

The marshlands, particularly Romney Marsh and the Norfolk Broadlands, however, provided excellent grazing. The latter could fatten a bullock on $1\frac{1}{2}$ acres of summer grazing. The former was an object of excellent management. The grass was grazed short by breeding ewes and fattening wethers and the only cattle brought on to the sheep pastures were lean stores to eat off the spring and early summer flush when the grass was running away from the sheep flock.

Grass farming was of better quality in many western, northern, and midland districts. The physical environment was more suited to grass and these districts were not preoccupied to the same extent with the new arable techniques. The methods of making hay practised in Cheshire were recommended to Suffolk farmers. The best Cheshire pastures were on 'a tolerably stiff clay soil'.[1] In Craven 'the old rich pastures about Skipton, Settle . . . makes a hay of great repute, and is generally used over the whole Riding'; and again, 'the graziers in general are very expert at their business'.[2] In North Stafford the valley of the Dove was 'extraordinarily fine grassland', and a footnote comment adds, 'The farmers are accustomed to say, that it is scarce possible to over-stock a few acres of Dove land'.[3] This was the same district that Leland had noticed nearly three centuries before. The clay soils of Leicester, Northampton,[4] Warwick, Oxford, and Buckingham had become famous feeding districts which drew in stock from Wales, the Welsh Border, and the South-west Peninsula. The Buckingham reporter wrote of the Vale of Aylesbury: 'Its amazing fertility soon makes a visible alteration in the appearance of the animal . . . a proof of the quality and ability of the land'.[5] Many of the county reporters quote these Midland clays as essentially grass soils and as examples of improvements effected by laying deep clays down to grass.

In the extreme western districts of Wales and the Lake District grass farming was the main form of land utilization and stock rather than crops the main object of management. It had been so in the Middle Ages, but arable had fallen to even lower levels by the end of the eighteenth century. Many Welsh counties imported corn for human requirements and some districts limited their arable to the production of winter stock food. This was equally true of Cumberland and Westmorland.[6] The management of the grass was designed largely to secure as much winter grazing as possible. In Anglesey,

[1] Holland, op. cit., p. 170.

[2] Rennie, Brown, and Sherriff, op. cit., pp. 116–17, 119–20.

[3] W. Pitt, *General View . . . Staffordshire* (1796), p. 69.

[4] Norden, writing of Northampton in the seventeenth century, had referred to 'Meadowes and deepe feedings' in the valleys and to 'the Feelds on the Hills above' (*Speculi Britanniae Pars Altera* (1620)).

[5] James and Malcolm, op. cit., p. 17.

[6] J. Bailey and G. Culley, *General View . . . Cumberland* (1797), p. 202; Pringle op. cit., pp. 274–5.

and perhaps elsewhere also, cattle were kept out of doors the winter through.[1] Fogging pastures was widely followed. The pastures were shut up early in the grass season and were not opened to stock until late autumn: in these mild, moist western districts, where grass could continue to grow until Christmas, it was held that an acre of fog was better than an acre of the best hay.[2] There was some butter-making and a little cheese, but the demand for Welsh store cattle on the deep Midland clays was too considerable to permit dairying to develop on any scale.[3] The Welsh mountain pastures and the Lake District fells were stocked with sheep in summer and a transfer up on to the mountain and fell in summer and down into the dales and valleys in winter was a regular rhythmic movement. Stock (cattle as well as sheep) were sent up in spring, the date varying according to the date when grass began to grow, and brought down about Michaelmas. The Carnarvon reporter had been informed that 'it was a common practice in this county, for families to go up to the mountains, in the summer season, to attend their flocks, and to reside in huts, in which they made cheese',[4] but he himself failed to find any traces of such transhumance in his day. It may be inferred that it had been practised earlier in the eighteenth century, but had since ceased. The decline of transhumance in Wales was linked with the substitution of sheep for cattle and with the enclosure of hill grazing.[5]

It would be interesting to analyse the geographical distribution of the several improved and unimproved breeds of stock at the end of the eighteenth century. I will confine my attention to cattle as an example. Although the old controversy of horse *versus* ox was still active in some districts, the Weald, for example, cattle were now bred primarily for meat and milk and not for muscle. The Longhorn still dominated North-west England and the West Midlands. The best Longhorn stock seems to have been in Lancashire and Craven, but Longhorns were found from Cumberland to Gloucester and Oxford. The Shorthorn had, in contrast, an eastern distribution, and it was still sometimes called the Dutch breed. But, as its milking qualities were becoming known, it was gradually spreading into other districts where dairying was the main objective. There were Shorthorns in Cheshire and in Somerset. They gave more milk than the Longhorn—3–4 cwt. of cheese[6] or 3 firkins of butter[7] in the season

[1] This was possible also in Somerset.

[2] T. Lloyd and Turnor, *General View . . . Cardigan* (1794), p. 18.

[3] In Pembroke the soil was good enough for fattening, but there were no markets for fat stock near by and for economic reasons only young stores were kept (Hassall, op. cit., p. 12).

[4] G. Kay, *General View . . . Carnarvon* (1794), p. 17.

[5] R. Alun Roberts, 'Trends in Semi-Natural Hill Pastures from the Eighteenth Century', *Report Fourth International Grassland Congress* (1937), pp. 150–1. He has discovered traces of transhumance in a modified form in Snowdonia as late as 1861.

[6] Billingsley, op. cit., p. 15.

[7] J. Bailey and G. Culley, *General View . . . Northumberland* (1797), p. 121.

as compared with 2½ cwt. of cheese[1] or 1–2 firkins of butter[2] of the Longhorn. The Shorthorn was clearly the more successful dairy cow. A few Channel Island cattle were found in Kent 'in dairies of gentlemen's families'. In the South-west Peninsula and in the south-west counties generally, the dominant breeds were red in colour, whether the Devon or the Hereford. These were good beef animals and were kept by graziers for fattening in these districts or for finishing on the deep clay pastures of the Midlands. The small black cattle of Wales were graziers' beasts also, and were brought by drovers to the Midlands and Kent. They were not good milkers, and when kept for milk yielded little more than 1 firkin of butter in the season. The bullocks fattened in the winter on the arable crops in East Anglia were mostly Scotch.

Contemporary with these improvements in crops and stock, there was proceeding a gradual reclamation of the waste. Light dry soils in western East Anglia and in Lincolnshire, which had hitherto been poor sheep pasture or rabbit warren, were improved and brought into cultivation through the agency of turnips and clover and the winter feeding of bullocks and sheep. Much open down was ploughed in the Central and Western Downlands (Hampshire, Berkshire, Wiltshire, and Dorset) and brought into arable cultivation with the help of sheep folded on the thin chalk soil. Defoe had noticed this in progress early in the eighteenth century, and it was active also at the end of the century.[3] The draining of the Fens,[4] though begun in medieval times, was not completed until the nineteenth century, and the draining and reclamation of much of the mossland of the Lancashire Plain had also to await the nineteenth century. But Pennine moor was being as actively improved as the open down of the English Plain, and it had been in progress early in the sixteenth century.[5] At this time population was attaining its highest altitudinal distribution. Small farms, which practised textile crafts and lead-mining (as at Alston) as well as farming, formed intakes around the moor edge. The farming of these small holdings was of a semi-subsistence type, though inadequate to supply the family, but away from the industrial and mining districts larger farms were being created. The bleak and exposed Forest of Knaresborough, for example, was brought into convertible husbandry, arable for a number of years succeeded by grass grazed by young growing stock.[6]

This increase in arable on down and moor compensated for the decline in arable on the deep clays of the Midlands. The total arable

[1] Pitt, op. cit., pp. 131–3.
[2] J. Bailey and G. Culley, *General View . . . Cumberland* (1797), p. 210. The firkin was a measure of capacity (7½ gallons) and not of weight.
[3] A. and W. Driver, *General View . . . Hampshire* (1794), p. 23.
[4] H. C. Darby, *The Medieval Fenland* (1940) and *The Draining of the Fens* (1940)
[5] G. H. Tupling, *The Economic History of Rossendale*, p. 42–69.
[6] Rennie, Brown, and Sherriff, op. cit., p. 142.

acreage probably did not decline,[1] but its geographical distribution was changing. The Midland clays had probably been in the Middle Ages the chief corn-growing districts of the country, but they had since been largely laid down to grass, though they still displayed the high ridge and furrow, whose ridges were possibly the lands or selions of the open fields and which were certainly designed to assist the drainage of these heavy soils. The light soils, many of them in upland areas relatively devoid of population since the English settlement, were, on the contrary, being transformed from sheep pasture to arable, though their sheep husbandry was being incorporated into the arable system with sheep folded on the arable. The light soils were the beneficiaries of the New Husbandry, the heavy soils of the new grazing and dairying. Nathaniel Kent, writing of Norfolk corn production, recognized this reversal in the geographical distribution of arable farming. 'It is evidently so great,' he says, 'that no part of England, not even the famous vales of Taunton, White Horse, and Evesham are supposed to exceed it in proportion of corn.'[2] The 'famous vales' had stiff or relatively stiff soils and had been heavy producers of corn. The same reversal was noticed, on a smaller scale, in the Vale of Belvoir. It was an agrarian revolution geographically as well as technically.

The new and improved methods of farming were most successful on enclosed land. Though much of the evidence is not of such a nature as to be incontrovertible, there was probably a difference in yield of corn between enclosed land and open field.[3] The average crop of wheat on the common fields of Nottingham was 16–24 and on the enclosed land 20–32 bushels per acre. The enclosed land had the advantage. Many other similar examples might be given. These returns do not, however, necessarily prove the point, for there may have been a difference in the intrinsic quality of the soil as between open and enclosed, that is, the addition of a second variable.[4] However this may be in respect of *yield*, almost every county report gives particulars of the higher *rent* of enclosed arable land as compared with common field arable. The increase was stated in particular counties to be one-quarter, one-third, one-half, two-thirds, and double the rent of open field arable. In Cambridgeshire the average rent of enclosed arable was 18*s.* and of open field arable 10*s.* per acre;[5] in Essex, 14*s.* 8*d.* and 10*s.* 2*d.*;[6] in Northampton, 20*s.* and 11*s.* respectively.[7] The average increased rent of enclosed arable thus appears to have been about two-thirds or three-quarters of the rent

[1] Caird was of the opinion that the arable acreage in 1850–1 was considerably greater than it had been in 1770 (Caird, op. cit., pp. 475–6).

[2] Kent, op. cit., p. 150.

[3] C. Vancouver, *General View . . . Cambridge* (1794), p. 192.

[4] Kent (op. cit., p. 73) seemed to have no doubts that enclosed land actually yielded more.

[5] C. Vancouver, *General View . . . Cambridge* (1794), p. 193.

[6] C. Vancouver, *General View . . . Essex* (1795), p. 115.

[7] J. Donaldson, *General View . . . Northampton* (1794), p. 14.

of open field arable. This higher rent was due to a greater profitability of farming on enclosed land, but it was also due to the customary character of common-field rents which held such rents down.

I will not attempt to examine the distribution of enclosure by Act. It is discussed at considerable length by Prof. E. C. K. Gonner and Dr. G. Slater in the works referred to earlier in this chapter. The enclosure of common field was in that stretch of midland England where the two- and three-field system had been practised in its most accentuated form: elsewhere common field had been enclosed long before. The enclosure of common waste by Act was in contrast most prominent in the Pennine and Welsh uplands. In the English Plain common waste had been enclosed piecemeal previously as a result of pressure of population.

The form of agricultural use adopted after enclosure by Act varied widely. It is certain that enclosure was not all intended for laying down arable to grass. This did happen extensively on the deep clays of the Midlands which had already become famous grazing districts. But much enclosure of the chalk was unquestionably for arable cultivation. The success of the New Husbandry ensured that all enclosed light soils would pass under the plough. Enclosure, therefore, was not only a tenurial change: it had profound geographical effects on the landscape and on the use of the land. It greatly altered the face of the countryside. Common-field cultivation was open and unhedged and only the coppices broke the sweep of the wind. It was a naked landscape, as Cobbett frequently described it, but it allowed sun and air to get to the growing crops. The chequer-board of the modern British countryside, with its hedges, fences, and walls, is a product of long-continued enclosure. It is a handicap to the ploughman, but it has its advantages to the stockman, for it enables him to manage both stock and grazing more efficiently. The open fields of the Middle Ages and the enclosed fields of to-day are, in fact, indicative of largely arable and largely pastoral types of farming respectively.

III

THE IMPROVING MOVEMENT IN SCOTLAND

The Improving Movement in Scotland came relatively late. In the seventeenth and eighteenth centuries there was a general air of agricultural backwardness. Celia Fiennes crossed the Border beyond Carlisle at the end of the seventeenth century, but she was glad to return:[1] she had the prejudices of the Southern English of the time. But Defoe was also struck by agricultural backwardness. Writing of the Lothians, one of the best cultivated parts of Scotland, he said, 'thus a good Soil is impoverish'd for want of Husbandry', and he

[1] C. Fiennes, *Through England on a Side Saddle in the Time of William and Mary* (ed. of 1888), pp. 170–1.

specified the improvements required as enclosed pastures, better winter feeding of cattle and sheep-folding in order to accumulate dung, and fallowing to permit the cleaning of the land.[1] Accustomed to the improved arable methods of the English Plain, he had put his finger on the weaknesses of Scottish arable practice. Defoe visited Scotland in the 'twenties of the eighteenth century and the Improving Movement did not substantially take shape, as Dr. Hamilton shows, until after the middle of the century.[2] By the time of the county reports at the end of the century, Scottish farming was a varied pattern of old and new. Writing in 1813, Sir John Sinclair remarked on the improvement in the last forty-four years.[3]

The process of change was, in general terms, similar to the process of change in South Britain, the specialization of production and the disappearance of common-field cultivation; and the agents of change were similar also, improved methods of tillage and the introduction of roots and seed grasses. There were legal and tenurial differences, of course, owing to the different character of Scots law.

Even before the middle of the eighteenth century there was a not inconsiderable regional specialization of agricultural production. East Lothian had a substantial corn surplus, wheat being sent to Portugal and Spain, oats to the Western Highlands and Ireland. This, according to the East Lothian reporter, was between 1720 and 1740.[4] Defoe reported a surplus of corn from the Carse of Gowrie and the Vale of Strathmore and an export from Dundee to England and Holland;[5] and he reported also an export from Aberdeen, 'but they generally bring it from the Firth of Murray or Cromarty, the Corn coming from about Inverness, where they have great Quantities'.[6] It will be noticed that these (East Lothian, Carse of Gowrie, Moray Lowlands) are all dry eastern districts of fertile soil and that export was not only to other parts of Britain, but also to continental Europe. Wheat was grown in all these eastern districts, indeed possibly as far north as Caithness.[7] On the other hand, much of the west of Scotland was a stock rather than a corn country. Even the lowland of Ayr, which Defoe described as 'rich and fertile', and which, after travelling through Galloway, reminded him of England again,[8] imported corn before 1750 across country from the Lothians.[9]

[1] Defoe, op. cit., pp. 699–700.
[2] H. Hamilton, *The Industrial Revolution in Scotland* (1932), p. 36.
[3] J. Sinclair, *An Account of the Systems of Husbandry adopted in . . . Scotland* (1813), vol. II, p. 72.
[4] G. Buchan-Hepburn, *General View . . . East Lothian* (1794).
[5] Defoe, op. cit., p. 806.
[6] Defoe, op. cit., p. 812.
[7] Defoe's reference to Caithness—'Very good Bread, as well Oat Bread as Wheat'—does not necessarily imply that wheat was grown there, for it may have been imported (Defoe, op. cit., p. 825).
[8] Defoe, op. cit., pp. 740–1.
[9] W. Aiton, *General View . . . Ayr* (1811), p. 533.

Galloway was essentially a stock district, rents were paid in stock and beasts were sent into England in great numbers. A Cheshire man travelling in Galloway in 1635 noted the absence of wheaten bread.[1] The Western and Central Highlands, as may be readily expected, were not self-supporting in corn except in years of good harvest,[2] and they also sent droves of cattle into England for fattening. Like Wales, Scotland contributed cattle to the English grazier and feeder.

The county reports at the end of the eighteenth century permit, as in England, the reconstruction of the agricultural geography of the time. There is additional evidence for Scotland in the *First Statistical Account*, published contemporaneously.[3] The most improved districts were East Lothian and Berwick;[4] they were the districts most closely in touch with England and they had the dry climate and (in part) the light fertile soil suitable for the New Husbandry. The effect of both space-relations and of local physical environment is clear. They both used Small's plough, an improvement, its users claimed, on the Rotherham plough.[5] This needed only two horses and one ploughman in place of the four horses or eight oxen with a driver as well as a ploughman which the old Scots plough required.[6] Small's plough was passing into general use throughout the Central Lowlands of Scotland by the end of the century, but the old Scots plough was still common in South Perth[7] and in Aberdeen.[8] Improved forms of plough had been introduced also into the lands around Moray Firth,[9] which in Defoe's time was an outlier of good cultivation. It is an outlier too of dry climate and mild weather. Clover and rye grass had been introduced into East Lothian in the 'twenties, turnips some twenty years later, and the Norfolk system about 1750. Both the clover and the turnip husbandry appear to have been adopted in Berwick about or just before 1750. Once proved successful, these new crops spread rapidly throughout the entire eastern side of Scotland.[10] In the west they were grown in Dumfries,[11] but in Ayr turnips were grown only in

[1] *North Country Diaries* (Surtees Society), Second Series, vol. CXXIV (1915), p. 45.

[2] I. F. Grant, 'Some Accounts of Individual Highland Sporting Estates', *Economic History*, no. 3 (1928), p. 406.

[3] *The Statistical Account of Scotland*, vols. I–XXI (1791–9).

[4] Hamilton, op. cit., p. 46.

[5] In the districts using improved ploughs Tull's principles of drilling and horse-hoeing were also employed.

[6] The Scots plough was sometimes used for working strong land, even in districts using a lighter plough for other purposes (B. Johnston, *General View . . . Dumfries* (1794), p. 41).

[7] J. Robertson, *General View . . . Southern Districts of Perthshire* (1794).

[8] J. Anderson, *General View . . . Aberdeen* (1794).

[9] J. Donaldson, *General View . . . Elgin* (1794).

[10] North of the Highland line improvement was far from complete at the end of the eighteenth century. In the parish of Cabrach in Banff rye grass was sown only in yards (*First Statistical Account*, vol. VII, p. 362).

[11] Hamilton, op. cit., p. 47.

gardens in 1773, though rye grass and clover were frequently sown preparatory to a ley,[1] and they were almost unknown in Argyll and the Central Highlands at the end of the century.[2] The potato had, however, come into general cultivation in both western and eastern districts, in both highland and lowland. In many cases it had been introduced in a famine year and had proved so successful that it had become a staple article of diet. 'This valuable exotic' was recognized to be useful in improving moss soils and was usually cultivated in a rotation as a fallow crop, though it was sometimes grown year after year in the same ground.[3] In eastern districts potatoes were planted alongside turnips and in the Carse of Gowrie replaced turnips in the fallow break.[4] It was cultivated much more generally than in England.

Those districts which practised the turnip and clover husbandry rarely, however, followed the Norfolk rotation. Only on the dry 'turnip and barley' soils of the Merse of Berwick[5] was it common, and it was occasionally encountered in East Lothian. In the Merse of Berwick the grain sown after clover was usually oats rather than wheat. When wheat was grown it was sometimes spring sown. These conditions reflect the cooler summers of North Britain. A common rotation on the dry coastal soils of East Lothian, where seaweed could be used for manure, was turnips–barley–clover (two years)–oats–pease or beans–wheat. But one reporter after another in these eastern districts made the statement that no regular system of rotation was followed. Perhaps there can be detected in this the persistence of the flexibility which was a mark of the old Scottish system. A rotation rigidly followed was more common of England, whose medieval agriculture had been dominated (in the midland belt) by the rigid two- and three-field system.

The alternation of white and green crop was not everywhere the rule. On heavy soils unsuited to turnips the old exhaustive rotation of fallow–wheat–pease–barley–oats was still to be found, but clover was in many cases being intercalated between the barley and oats. In Clydesdale, a moist western district, the clays were usually in convertible husbandry, an arable shift similar to the above, followed by a long ley.[6] The long ley was common also in western England. But Sir John Sinclair recognized that 'in soft soils and moist climates . . . the dairy ought to be the principal object of the farmer'.[7] In many districts the infield-outfield system still persisted. It is

[1] *First Statistical Account*, vol. VII, pp. 30 and 355 (Ayr).
[2] W. Marshall, *General View . . . Central Highlands* (1794).
[3] D. Ure, *General View . . . Dumbarton* (1794), pp. 52–3.
[4] J. Donaldson, *General View . . . Carse of Gowrie* (1794), p. 15.
[5] A. Lowe, *General View . . . Berwick* (1794), p. 28.
[6] J. Naesmith, *General View . . . Clydesdale* (1798), p. 69.
[7] Sinclair, op. cit., vol. II, p. 119. There was a good deal of dairying near Glasgow—milk selling within two miles, butter making over two miles, and cheese making over ten miles distant (vol. I, pp. 116–17).

described in the reports on East Lothian, the Carse of Gowrie, and Elgin as the old system which had gradually fallen into disuse since the middle of the eighteenth century. In the form of continuous cropping for corn, followed by years of recovery under self-sown grass, it was to be found in Tweeddale and Galloway. But in the Central and Western Highlands the infield-outfield system persisted almost unmodified.[1] Marshall estimated that on the sides of Loch Tay the 'nominal farms', that is, the farms of joint-tenants, had each 20 acres infield, 15 acres outfield, 10 acres meadow, 35 acres green pasture, and, beyond the head dyke marking the limit of the 'improved' land, 250 acres of muir. It was the Highlands that were most backward in methods of land utilization.

The increased winter food provided by turnips, seed grasses, and, to a smaller extent, by potatoes, effected in Scotland, as in England, a revolution in stock husbandry.[2] Winter food had been scarcer, so writers seem agreed, than in England, and it was not uncommon for one-fifth of the young stock to die during the winter and for stock to be lifted or carried in the spring, so weak had they become.[3] Marshall describes the paring of land 'to the quick' in the efforts to gather wisps of hay from roadsides, from wood bottoms, and from rushy patches in the pastures which stock would not touch in summer when better herbage was available. Straw was not infrequently more nutritious. The large-scale export of cattle in the eighteenth century, from the Highlands and Galloway particularly, but from the far corners of the Hebrides and Caithness as well, was in autumn at the end of the grass season. With free access to the English market after the Union, export of cattle to England grew in volume as the population of England grew, but especially as the New Husbandry with its demand for cattle for winter feeding gradually spread over the light soils of East England. At the end of the century Sir John Sinclair estimated the annual export to England at 100,000 head. Both the Galloway and the West Highland Kyloe were good feeding animals. They were, however, small, Galloways in Ayrshire weighing when fat 18–27 stone only.[4] The Scottish Improving Movement, with its roots and hay, ultimately decreased this export of lean stores, but not until the first half of the nineteenth century. By the time of the *New Statistical Account* (*c.* 1840) large numbers of cattle were being fattened on turnips and clover within Scotland and exported by steamship coastwise as fat

[1] J. Smith, *General View . . . Argyll* (1798), p. 30; Robertson, op. cit., p. 24; W. Marshall, *General View . . . Central Highlands*, pp. 30–1.

[2] In Berwickshire good grass would now support an ox or five adult Leicester sheep per acre and ordinary grass a bullock or four and a half shearling Leicesters per one and a half acres (Sinclair, op. cit., vol. I, pp. 110–12).

[3] Hamilton, op. cit., p. 21.

[4] These would presumably be carcass weights (*First Statistical Account*, vol. I, p. 107).

beasts. The steamship, with its short journeys of a day or two, replaced the long months along the drove road when stock inevitably lost condition. It was not until the nineteenth century that the black polled Aberdeen-Angus beef breed took shape in its present-day form,[1] though the Galloway and the West Highland Kyloe were in existence in the eighteenth century.

By the end of the eighteenth century there had begun the great transformation in the land utilization of the Highlands whereby the cultivation of corn and the rearing of cattle came to be replaced by the keeping of sheep for wool and mutton. The Highlands had been relatively highly populated, 'overstocked with inhabitants', in Marshall's opinion,[2] owing to the clan system and its demand for men to bear arms. As much corn for local consumption was grown as possible by the infield-outfield system, cattle were bred, and sheep were kept mainly for milk. Highland cattle do not yield much milk and, although for suckling only one calf was allowed to two cows, little was available for cheese or butter.[3] It was the custom to transfer stock to the summer shielings for six to seven weeks in order to save the pasture near the homestead as much as possible. The practice had been abandoned within living memory around Loch Tay, but it was still followed in Glen Garry.[4] The shielings have continued to be used in the Hebrides almost to our own day. The milked sheep were being replaced by the Blackface, a North Pennine and Southern Upland stock, more capable of grazing on the bleak mountain pastures. The milked sheep had always remained near the homestead. First, the southern fringes of the Highlands were affected, in Dumbarton and Perth, then Argyll and Inverness, and before the end of the century Cromarty and Sutherland. The Cheviot had spread with the Blackface, but on the less bleak and more grassy slopes. These sheep were grazed on the mountain in summer and were wintered in the straths and glens. Their summer grazing displaced cattle and their wintering displaced much arable cultivation. Although the depopulation of the Highlands had begun before sheep-farming had become at all extensive,[5] sheep greatly accelerated the movement. The clearances for deer forests and grouse moors did not come until later in the nineteenth century. Some of the displaced population was settled in crofter communities, but most went to the Lowlands or overseas.

The Southern Uplands had become almost entirely a sheep district. The county of Selkirk had only three or four farms wholly in arable at the end of the eighteenth century, and two dozen which might

[1] Wallace, *Farm Live Stock of Great Britain* (1923), pp. 161–4.
[2] W. Marshall, *General View . . . Central Highlands*, p. 21.
[3] W. Marshall, *General View . . . Central Highlands*, p. 45.
[4] W. Marshall, *General View . . . Central Highlands*, pp. 45–6.
[5] Hamilton, op. cit., p. 68–9; Grant, *Economic History*, no. 3 (1928), p. 407.

be described as semi-arable sheep farms. Of the rest some grew just sufficient oats for the household and the horses, but others grew no corn whatever. The Blackface was here confined to the bleaker uplands, the rest being grazed by a white-faced cross-bred (Blackface ewes × Cheviot tups). The flock was kept on the uplands except in bad weather, and was stocked in summer at the rate of one to two sheep per acre. The Southern Uplands provided fairly good grass pasture and even the rocky Highlands yielded better summer grazing than Blackamore in North-east Yorkshire, in Marshall's opinion. The Peebles reporter gave particulars of three type farms in Tweeddale as an example of variations in seeding and yield at different altitudes. From these particulars Table III has been constructed. Farm A was a valley farm, farm B on the lower slopes, and farm C on the upper slopes. Wheat and barley were grown only on the lower and better ground and bere only on the upland farms. Yields gradually decreased, when reckoned as a return on seeding, with elevation.

TABLE III

Crop Yields and Seeding per acre in Tweeddale 1794

	Seeding and Yield in Bolls					
	Farm A		Farm B		Farm C	
	Sown	Yield	Sown	Yield	Sown	Yield
Wheat . . .	10	90	—	—	—	—
Barley . . .	22	210	—	—	—	—
Bere . . .	—	—	7½	68	5	40
Oats . . .	90	540	40	200	32	130
Potatoes . .	6	150	4	60	2	20

From T. Johnston, *General View . . . Tweeddale* (1794).

The Improving Movement in Scotland, like the New Husbandry in England, was accompanied by, if it did not cause, the disappearance of cultivation in common. The open unfenced landscape cultivated in run-rig was replaced by the rectangular enclosures of the new system.[1] It often involved a quite considerable replanning of the settlement sites, the field pattern and the roads, some examples of which have been worked out by Dr. Geddes.[2] In the Highlands the only new fences were the straight lines up the mountain-sides. The small size of the agrarian unit, the hamlet rather than the village,

[1] At the time of the *First Statistical Account*, the parish of Linton in the Southern Uplands had, according to the terms used by the minister reporting on it, its croftlands 'enclosed' and its outfield 'uninclosed' (vol. I, p. 140). The croftland was under continuous cultivation: the outfield under occasional.

[2] A. Geddes, 'The Changing Landscape of the Lothians, 1600–1800', *Scottish Geographical Magazine*, vol. LIV (1938).

presumably facilitated agreement amongst its members and the flexibility of the field systems, as in the early enclosed parts of England, presumably facilitated the replanning of cultivation. Every reporter who discussed the point was agreed that enclosure increased the value of the land, the amount of the increase varying, as in England, from one-third to double the previous figure.

IV

THE NINETEENTH CENTURY

The replacement of the old by the new agriculture was not by any means complete by the beginning of the nineteenth century, but by this time the new order was dominant and the old recessive. The new order had certain economic implications which it is necessary to notice. The full delineation of these is the province of the economist, but as they reacted on geographical distributions they are germane to the present treatment. The economic environment, at all stages in the evolution of the economic geography of Britain, had differential reactions on different regions of the country.

In the first place, farming for a market implied dependence on the price fluctuations of the market. As long as subsistence farming was practised and the produce of the land consumed on the farm, price fluctuations had only a limited significance. Under the new order, high prices for a particular commodity implied an extension of the area producing that commodity into lands normally marginal.[1] Conversely, low prices meant a contraction of the area of production into those regions where the optimum *economic* conditions for the production of that commodity obtained. The districts presenting optimum economic conditions were not necessarily those with the highest yields per acre (in the case of arable crops), but those with the maximum return for effort expended. Light soils often did not produce as heavy crops of wheat per acre as stiff clays in a favourable year, but they were much easier and less expensive to work and the financial return, balancing expenses and returns, was greater. Medieval farming, prodigal of labour, grew its wheat mainly on stiff soils which gave the highest yields under medieval methods, even though they were laborious to work. The revolution in the distribution of British arable farming, from stiff to light soils, has already been noticed as in progress by the end of the eighteenth century. It was to become much more pronounced, as will appear, during the course of the nineteenth century.

In the second place, the price fluctuations of the market were no longer determined simply by British conditions alone, by the relation

[1] For an application of this principle to world wheat production, see R. O. Buchanan, 'Some Features of World Wheat Production', *Scottish Geographical Magazine*, vol. LII (1936).

between supply and demand within Britain, by good and bad harvests in the case of crops and arable-fed stock or by abundance and scarcity of grass in the case of grass-fed stock. William Cobbett insisted that good and bad harvests in Britain had ceased by the time of the *Rural Rides* to be the sole factor determining the price of corn. The effect of the season continued to operate, but British wheat production had ceased to be sufficient, except after an exceptionally good harvest, for the consumption needs of the country.[1] As the manufacturing population of Britain grew and as the gap between corn production and corn consumption widened, import increased. Costs of production and variations in harvest in the remote corners of the world began to affect corn prices and the acreage under crop in Britain at home.

In the third place, exposure to market conditions and later to 'the world price' required great elasticity of farming practice and great mobility of labour. The conservatism and rigidity of medieval farming and the fixity of the medieval population, though neither were complete, were unsuited to the new conditions. Elasticity of farming was at times an essential condition of economic survival. Enclosure greatly increased the mobility of labour, though in the South of England its effects in this respect were masked for a time by the Speenhamland policy.[2] On enclosure, many small freeholders sold their holdings as, deprived of common rights, their few arable acres ceased to be an economic unit under methods of capitalistic farming. The mere expense of hedging was sometimes beyond their pockets. Many copyholders ceased to farm.[3] The cottagers with an acre or less filched from the waste, who had no legal title to any land and who were admitted to the commons on sufferance and not by right, frequently became landless, though in some enclosure awards they were allotted substantial gardens and occasionally small commons were preserved for their sole use. Many of the smaller cultivators and all the cottagers thus became landless labourers dependent entirely on wage labour on farmers who, in their turn, had become dependent largely on price fluctuations. When prices fell, labourers fell out of employment and, as they had no land to tie them to any particular village, they were free to migrate elsewhere, except when tied by poor law regulations.

As the price of corn affected arable farming so profoundly, it is necessary to analyse briefly the course of corn prices during the nineteenth century as a preliminary to an examination of their effects on the geographical distribution of arable farming within Britain.

[1] *Minutes of Evidence*, Select Committee on Agriculture, 1833. Evidence of W. Jacob, D. Hodgson, T. Oliver, and J. Sanders.

[2] J. H. Clapham, *An Economic History of Modern Britain: The Early Railway Age* (1926), p. 131.

[3] The yearly tenants had little claim on the land and the holders of lease or life interests could be bought out.

Of the four grains, wheat was the most involved in commercial farming and most affected by price fluctuations. Rye had become less and less important.[1] Oats was a staple bread corn in the North of England and in Scotland, witness Dr. Johnson's famous definition of oats as food for men in Scotland but for horses in England. The substitution of horses for oxen in the eighteenth century had greatly increased the demand for oats, but oats did not enter largely into trade. The better qualities of barley were grown for malt and the rest fed to stock.[2] The average annual price of wheat per imperial quarter in Britain from 1771 to 1939 is set out in Fig. 3. Certain phases are easily discernible.

(*a*) Before the Revolutionary Wars prices were arranged in cyclical fluctuations with minima of 35–40*s*. and maxima of 54–55*s*. per quarter, an average of 47*s*.

(*b*) During the Revolutionary and Napoleonic Wars the price of wheat rose to very high levels, to 119*s*. in 1801 and to 126*s*. in 1812. It was still subject to fluctuations, but these had become irregular.

(*c*) After 1820 and until the end of the 'fifties, prices fell to more normal levels, an average of 56*s*. per quarter, which was higher than the pre-war average. It fluctuated between minima of 40–50*s*. and maxima of 68–75*s*., exhibiting the same regularity of arrangement as in the pre-war period.

(*d*) In the 'sixties and 'seventies the amplitude of fluctuation was greatly reduced. Minima remained at similar levels as in period (*c*), but maxima did not rise beyond 64*s*. per quarter. The average for the period was 51*s*.

(*e*) After the 'seventies prices fell steadily, with only a slight recovery in 1891, to a minimum of 23*s*. per quarter in 1894–5. From this trough the price of wheat gradually recovered, passing 30*s*. in 1907 and remaining above this level until the outbreak of the war of 1914–18. The cyclical fluctuation, so marked in earlier periods, had been damped down and had practically disappeared.

It was possible during the eighteenth century for Britain to produce all the corn required for home consumption, except in years of bad harvest. Increase in production was proceeding both by the adoption of improved methods of farming and by the bringing of new land into cultivation. Fluctuations in price were determined by harvest conditions within Britain. Improvement in farming method and reclamation of down and moor were most active during

[1] A witness before the Select Committee of 1833 stated that a little rye was consumed as bread corn in North-east Yorkshire and in North Wales, but not apparently to his knowledge elsewhere. Q. 85.

[2] The consumption of barley for bread was also rapidly on the decline. Select Committee of 1833. Q. 88 and 3431.

the wars when prices were especially high and when obviously marginal land was sown—chalk down with only a few inches of soil and Pennine moor at an altitudinal limit for the ripening of corn.

After the wars, it was gradually realized that conditions were changing. The gap between consumption and production was widening, and it was becoming clear that additional supplies would be forthcoming from abroad, not only from Europe, but also from overseas, particularly North America. There was no fear that the population of the country would starve. The Anti-Corn Law League, representing the manufacturers, began its agitation for free trade in

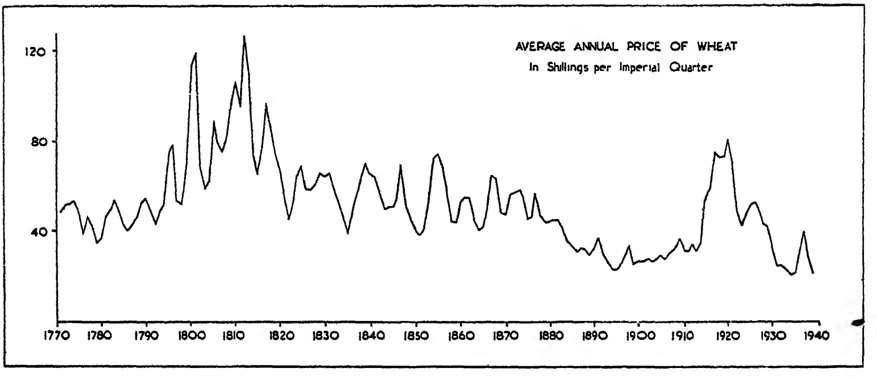


Fig. 3

AVERAGE ANNUAL PRICE OF WHEAT, 1771–1939

In shillings per Imperial Quarter.

corn in order to assist the development of a reciprocal trade of British manufactures for overseas wheat and in order to lower the cost of living for the workers in their employ.[1] Repeal was not supported by the manufacturers alone, for many held that the admission of foreign corn would reduce the fluctuation of corn prices incident upon good and bad harvests.[2] William Cobbett, who was no friend of the manufacturers, opposed the corn laws on the grounds that they 'could do us no good'. Nevertheless, the repeal of the corn laws did represent the victory of the manufacturing over the agricultural interests. The Select Committee of 1833 was concerned about the relative proportions of the agricultural and industrial

[1] D. G. Barnes, *A History of the English Corn Laws from 1660 to 1846* (1930), p. 288.

[2] The burden of many of the questions asked of witnesses appearing before one Select Committee after another was the price at which corn-growing could be profitably carried on. One witness before the Select Committee of 1833 was asked the question, 'What would be the price of corn . . . supposing the trade in corn were entirely free?' The reply was 38–40*s.* per quarter (Q. 3205–8). With wheat at 56*s.* per quarter, a Wiltshire witness held that the minimum yield per acre to pay expenses, exclusive of rent, would need to be 24 bushels on stiff and 16 bushels on light soils (Q. 1221–3). This was a very significant statement.

elements in the English population, and it was reported in evidence that even in 1811 the 'extraordinary and unexpected' conclusion was that of the total number of families 34·7 per cent were employed in agriculture and 45·9 per cent in trade and manufacture.[1] Britain was becoming primarily industrial and its economic policy was coming to be modelled on that basis. The repeal of the corn laws had for a time the effects that Cobden and Peel hoped. The average price fell from 56*s.* in period (*c*) to 51*s.* in period (*d*) and the amplitude of fluctuation was damped down considerably. These were not years of depression. Lawes and Gilbert imply that the 'sixties were years of 'great prosperity'.[2] But imports were increasing and in 1872–3 for the first time the net imports of wheat exceeded home production

TABLE IV

Acreage, Production, and Import of Wheat in the United Kingdom, 1852–78

	Acreage	Yield (bushels per acre)	Home Production (quarters)	Net Import (quarters)
1852–9	4,092,160	28	14,310,779	4,652,784
1860–7	3,753,011	28⅜	13,309,247	8,097,761
1868–75	3,792,636	26⅝	12,699,155	10,745,568
1876–8	3,266,335	27⅛	11,116,910	13,700,386

From J. B. Lawes and J. H. Gilbert, 'On the Home Produce, Imports, Consumption and Price of Wheat, 1852–3 to 1879–80', *Journal Royal Agricultural Society*, Second Series, vol. XVI (1880), Table V. The figures are annual averages.

and, save for the good harvest season of 1874–5, they continued to do so from that time onwards.[3] These figures, calculated by Lawes and Gilbert, are set out in summary form in Table IV. The acreage began to contract in the 'sixties, according to this table, before the catastrophic fall in prices began, but the acreage figures for England prior to 1866 (and for some of these years for Scotland) are estimates. The increased import was not from Europe, but from North America, and from quite a different type of farming. The virgin lands of the Middle West could, worked by family labour, produce wheat cheaper than the English farm. Production per acre may not have been high, but costs of production were low. In the early part of the nineteenth century shipments from North America had been mainly of flour, for cost of transport by land in the pre-railway age and by sea in sailing vessels was relatively high. But the development of the steamship and railway greatly reduced transport costs and raw wheat could

[1] *Report*, Select Committee of 1833, p. 7.

[2] J. B. Lawes and J. H. Gilbert, 'Our Climate and our Wheat Crops', *Journal Royal Agricultural Society*, Second Series, vol. XVI (1880), p. 173.

[3] J. B. Lawes and J. H. Gilbert, 'On the Home Produce, Imports, Consumption, and Price of Wheat, 1852–3 to 1879–80', *Journal Royal Agricultural Society*, Second Series, vol. XVI (1880), Table V.

enter the British market freely and cheaply.[1] The price of wheat fell catastrophically and until the war of 1914–18 remained at levels lower than the average for the whole of the eighteenth century. Although other corn crops were involved in this fall of prices, their price did not collapse to the same extent. The price of oats during the 'nineties and first decade of the twentieth century did not fall below the level of the 1770–90 period. The Select Committee of 1833 was set up specifically to inquire into agricultural distress. Some whole districts, it discovered, had fallen out of cultivation altogether and elsewhere the general standard of farming had deteriorated. This was not true of all arable farming, however. There was a striking contrast between light soils, where the standard was maintained, and heavy clays, where deterioration was universal. The contrast had been heightened by a series of wet seasons immediately prior to 1833, when the crops on the wet retentive land had suffered badly, but the contrast was more deep-rooted than that. It has been pointed out that at the end of the eighteenth century the improved system of the New Husbandry had been adopted extensively on light soils within the English Plain and that the heavy soils, to which the turnip husbandry was unsuited, were not cultivated to the same extent on the new principles, and that many retained, even when enclosed, the old medieval rotation. The contrast at the end of the eighteenth century was due chiefly to the fact that the new arable technique was a light-land technique. But in the nineteenth century an additional differential began to emerge. By 1833 it had become clear that light soils were cheaper and heavy soils more expensive to till. Relative expense of cultivation was becoming an important factor in proportion as commercial farming became dominant. A heavy soil was more expensive to work as it often required double the number of horses in a plough-team and as it needed elaborate draining which involved not only capital expenditure in laying the drains, but also recurrent expenditure in scouring the ditches.[2] Its yield was also more uncertain.[3] The loss of crop on clay in a wet season owing to defective drainage was placed as high as 4–12 bushels per acre in the North Riding, a very substantial proportion of the total crop.[4] Every witness was of the opinion that the clays would go out of cultivation first, and in fact the concentration of the

[1] In 1878 J. Caird calculated that 'the cost of transporting a quantity equal to the produce of an acre in England is seldom less than 40 sh., . . . an advantage equal to the present average rent' ('General View of British Agriculture', *Journal Royal Agricultural Society*, Second Series, vol. XIV. (1878) p. 280).

[2] As indicative of the higher costs of working, a Wiltshire witness held that, in order to meet expenses (exclusive of rent), the heavy land must yield 24 bushels of wheat per acre as compared with 16 bushels on the light land. The implication was that heavy soils cost half as much again to work as light soils (Q. 1221–3). There was much poor clay that yielded only 16 bushels of wheat per acre. In Clun Forest there was poor clay yielding only 9 bushels per acre (Q. 606).

[3] Q. 228 and Q. 1046.

[4] Q. 2398.

arable on the light soils was progressive during the whole of the nineteenth century. A member of the Committee, having in mind the concentration of medieval wheat farming on clay and the suitability of wheat to a stiff soil, asked the significant question, 'Do not we rely for our supply of wheat mainly on these clay soils?' He received the equally significant reply, 'No; the supply of wheat for the last thirty years has been very much increased from the sand lands, and from the strong loam.'[1] In the west deterioration was not noticeable. In some districts, South Salop[2] and Cornwall,[3] progress was even reported, but it is clear that this progress represented a lag in improvement. The principles of the New Husbandry were still in process of adoption. But even here some of the heavy land was ceasing to be arable.[4] These western districts, when in arable, did not rely on wheat to the same extent as the arable districts of the east.

Within a few years of the repeal of the corn laws, there appeared a first-hand account of English agriculture by James Caird.[5] Caird's survey has a distinctly modern flavour. In the course of his tours he came across an instance of common field in Berkshire. He placed it in inverted commas and considered it necessary to explain to his readers what a common field was, such an historical curiosity had common-field cultivation become.[6] In reporting methods of crop cultivation, he added a specification of the artificial fertilizers employed[7] and discussed their relative merits for different crops and under different conditions of soil and climate.[8] Similarly, in reporting stock rations, Caird frequently registered the feeding of oil-cake in winter to fattening beasts and to dairy cows at the rate of 3–4 lb. per head per day. This use of artificial fertilizers for crops and of concentrated foods for stock freed the farmer from the necessity of adhering rigidly to the standard rotations laid down some generations previously.

It is clear from Caird's regional survey that in many districts there was an approximation to modern forms of land utilization. The more general points only will be considered here, and only in so far as they bear on the evolution of the agricultural geography. Caird was fully aware of the changing agricultural distributions of his day and, in particular, of the changing character of clay-land farming

[1] Q. 1047. [2] Q. 375–8. [3] Q. 3361. [4] Q. 478.

[5] J. Caird, *English Agriculture in 1850–1* (1852). See also L. de Lavergne, *The Rural Economy of England, Scotland, and Ireland* (1855), a more general account of the British Isles based to a less extent on first-hand knowledge.

[6] Caird, *English Agriculture in 1850–1*, p. 115.

[7] The early work at Rothamsted was largely concerned with manures and fertilizers. Lawes himself was a manufacturer of superphosphates. He entered into the occupation of Rothamsted in 1834.

[8] In this railway age, when the railway was gradually spreading its tentacles over the countryside, some farmers experimented with a light portable tramway for carting turnips in order to prevent poaching of the land by horses, in much the same way as in the present motor age farmers have fitted pneumatic tyres to their farm carts.

from arable to grass and of the increasing tendency for market gardening and milk production to develop on suitable soils near the large centres of consumption, the market gardening on sand and the dairying on clay. He was not only aware of these changes, but he specifically encouraged them in certain cases as more profitable uses of the land.

Most of the bad arable management was in clay districts. Old-fashioned rotations of fallow–wheat–beans or fallow–wheat–oats were still encountered and Caird asserts that in some of these cases the yield per acre was actually declining.[1] The Oxford Clay was described to Caird as 'too strong for cultivation, and too weak to carry crops'.[2] Of the South Essex Clay, he writes, 'that great exertions are necessary to render its cultivation profitable',[3] and he advises the Essex clay-land farmer, within easy rail distance of London, to supply London with milk. He does not suggest grass dairying, however, in this instance, but house-feeding on clover and tares in summer, mangolds and cabbage in winter.[4] In reference to the stiff Lias Clay in Warwickshire, which was rented as low as 15*s.* per acre while sandy loams were at 25–45*s.*, Caird makes the comment that the stiff soils were even then rented too high.[5] The clay had fallen into disrepute as an arable soil. At the end of the eighteenth century the clay was not adapted to the turnip husbandry, but in 1850 mangolds were being grown on many relatively heavy soils. The expense of working them rather than the lack of a suitable improved rotation had now become the chief deterrent to their treatment as arable.

The second change in progress which Caird noticed was the growth near the large towns of market gardening and of dairying for the

[1] Caird, *English Agriculture in 1850–1*, p. 340.
[2] Caird, *English Agriculture in 1850–1*, p. 113.
[3] Caird, *English Agriculture in 1850–1*, p. 134.
[4] Caird, *English Agriculture in 1850–1*, p. 142.
[5] Caird, *English Agriculture in 1850–1*, pp. 221–2. Another example of the same difference is furnished by the following table:

Region	Type of soil	Arable acreage	Costs per acre		Yield per acre (bushels)		
			Rent, taxes, etc.	Working expenses	Wheat	Oats	Barley
			s. d.	*s. d.*			
Howdenshire .	Poor clay	149	19 3	47 6	20	28	24
Holderness . .	Good clay	326	31 11	49 5	33	50	—
York Wolds . .	Chalk	618	31 10	51 5	30	48	35
Lincs Wolds . .	Chalk	1,541	33 10	62 2	33	61	42

The table has been constructed from particulars of individual farms collected by Caird (p. 320). The poor clay of Howdenshire (within the East Riding but west of chalk scarp) had working expenses almost as high as the other soils, but a yield very much lower.

sale of liquid milk. There had been market gardening on the outskirts of London since the seventeenth century, fostered by, as Cobbett put it, 'the demand for crude vegetables, and repayment in manure'.[1] But elsewhere it was relatively new. By the side of the Bridgewater Canal at its Manchester end and on sandy soils in North Wirral, near Birkenhead,[2] an early and a main crop of potatoes were lifted from the sand land and sometimes a winter crop of cabbages as well. This heavy cropping necessitated heavy manuring.[3] The sandy soils along the Fylde coast were also potato lands and at least one Fylde farmer fattened lambs for sale to the coastal villages 'during the sea-bathing season'.[4] Caird advised similar potato cultivation on the sands of South Hampshire, the towns of which were then being supplied from France.[5] By 1850 dairying was ceasing to mean solely the making of butter and cheese, for liquid milk was being sold in increasing quantities at 2*d.* per quart. Lavergne's opinion was that 'the consumption of milk under every form is enormous among the English',[6] and the price of liquid milk in England was twice what it was in France, indicative, so Lavergne thought, of a greater demand. Caird reprimanded the grass farmers near the rising towns of Warwickshire for keeping only young stock 'just as if such a market for dairy produce had been 100 miles distant' instead of at their own doors.[7] Cow-keeping within the towns was then the main source of milk supply for the West Midland industrial population, and such milk sold at 3*d.* per quart, indicative, no doubt, of the expensiveness of this form of production.[8] Urban cow-keeping has since declined greatly with the development of the liquid milk market and is now found only under special circumstances as in Liverpool. In the upland parts of eastern Lancashire and the West Riding, where the greater part of the land, always too cold and wet for successful corn-growing, was in grass, milk for urban consumption was already the chief object of agricultural production.

In 1866, largely as the result of Caird's advocacy, the first agricultural returns for England were collected. It took some years for the particulars required to be uniformly understood by all those making returns, but by 1870 many of these difficulties had disappeared.[9]

The distinction between arable and grass districts in England and Wales or, to adopt the nomenclature of the reports on the returns

[1] Cobbett, op. cit., vol. 1, p. 57.
[2] This dated back to the end of the eighteenth century.
[3] Caird, *English Agriculture in 1850-1*, pp. 261–2.
[4] Caird, *English Agriculture in 1850–1*, p. 281.
[5] Caird, *English Agriculture in 1850-1*, p. 94.
[6] Lavergne, op. cit., p. 34.
[7] Caird, *English Agriculture in 1850-1*, p. 227.
[8] Caird, *English Agriculture in 1850-1*, p. 228.
[9] In 1866, for example, permanent pasture was described as exclusive of hill pastures. Many occupiers excluded their downland accordingly. The description was altered the following year to permanent pasture exclusive of heath or mountain land. In the early years, to give another example, some of the returns of fallow included waste and not simply bare fallow in rotation, as was intended.

for 1869–70, between corn and grazing counties, was clearly marked. In 1850–1 Caird had earlier noted the same distinction. Both Caird and the reports attempted to draw a line between them, but their lines do not everywhere coincide. They are both given in Fig. 4. It was indeed impossible to draw such a line, for some of the arable counties contained grass districts and some of the grass counties arable districts, such as South-west Lancashire. The East Riding,

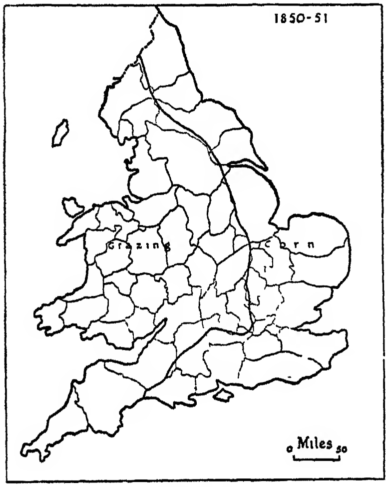


Fig. 4A

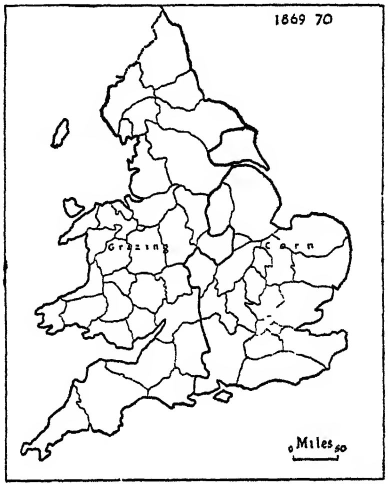


Fig 4B

CORN AND GRAZING COUNTIES IN ENGLAND AND WALES IN THE NINETEENTH CENTURY

A is according to J. Caird, *English Agriculture in 1850–1* (1852), and B according to the *Agricultural Returns* for 1869–70. In each map the *corn* counties lie to the east and the *grazing* counties to the west of the thick line.

Lincoln, Norfolk, Suffolk, Essex, Huntingdon, Cambridge, Hertford, Bedford, and Berkshire, were arable counties wherever the line was drawn; they had over 70 per cent of their total cultivated land in arable and most of them over 60 per cent of their total area.[1] To the west of these, grass and arable districts interdigitated—grass on the deep clays of the Oxford (in their southern drift-free parts) and Lias Clay Vales, arable on the chalk and Jurassic uplands—and, as some of these counties consisted almost equally of both types of land, they could with equal justification be placed in either group. Nottingham and Oxford had 50–60 per cent of their total area in arable and Northampton, Rutland, Warwick, Buckingham, Worcester, Gloucester, Wiltshire, Hampshire, Sussex, and Kent[2] had 40–50 per

[1] For the percentages, see Appendix A and Fig. 5.

[2] The 1870 returns do not include the acreage under orchards and small fruit. The inclusion of these in the arable would substantially increase the arable acreage of Kent.

cent. In the west arable was generally subordinate to grass. Arable was less than 30 per cent of the total area in Cumberland, Westmorland, Lancashire, Cheshire, the West Riding, Derby, Monmouth, Somerset, and in all Wales, except Denbigh and Flint, Anglesey and Pembroke. The South-west, however, had relatively more arable, Cornwall having 42·2 per cent of its total area and Devon 38·7 per cent—which represented a very substantial proportion of the *cultivated* land.[1] In the north-east, Northumberland and Durham had arable along the coast, but as both these counties include much Pennine upland the proportion of their total area in arable was necessarily low (see Fig. 5).

The distinction between the arable counties of the east and the grass counties of the west can be substantiated further by an examination of the individual crops involved in arable cultivation (see Fig. 6). All the counties east of the Jurassic escarpment had under 21 per cent of their arable in temporary or rotation grass, except Hampshire and Dorset, whose emphasis on grass-fed as well as on root-fed sheep presented rather special conditions. The same counties, with the same exceptions, had over 50 per cent of their total arable in corn, used in its widest sense to include beans and peas. Westwards, the percentage under corn diminished and the percentage under rotation grass increased. In Cornwall, Cumberland, and Westmorland, under 40 per cent of the total arable was in corn and over 30 per cent in rotation grass. In these western counties the higher rainfall discouraged corn and favoured the long ley. This feature had been strongly marked at the end of the eighteenth century, and convertible husbandry, involving the long ley or else the more primitive method of allowing the land to reclothe itself with self-sown seed, had characterized these western districts earlier still. There were wide variations in the particular corn sown. Wheat was widely grown and in most counties took up 20–30 per cent of the arable. This was prior to the collapse of corn prices owing to American competition. It was most important of all, expressed as a percentage of the total arable, on stiff clay soils within the English Plain, in Huntingdon or Warwick, for example. Wheat was least important in northern and western districts, and in Cumberland, Westmorland, and West Wales from Anglesey to Pembroke, it took up less than 10 per cent of the

[1] The total area includes arable, permanent grass, rough grazings, agriculturally unproductive land, and built-up areas. The cultivated land includes only arable and permanent grass.

Fig. 5.—A is *Arable*, B *Permanent Grass*, C *Cows and Heifers in Milk and in Calf*, D *Sheep over one year*. A and B are expressed in number of acres, C and D in number of head, in all cases per 100 acres of total agricultural area of each county. Maps constructed from the *Agricultural Returns* for 1870. The scale of shading is identical in A and B. In C and D the scale of shading is such that, except for the lowest densities, 5 head of sheep are equivalent to 1 cow. For the validity of this ratio in a particular case see my paper ('A Live-Stock Index for the Fylde District of Lancashire', *Empire Journal of Experimental Agriculture*, vol. VII (1939).

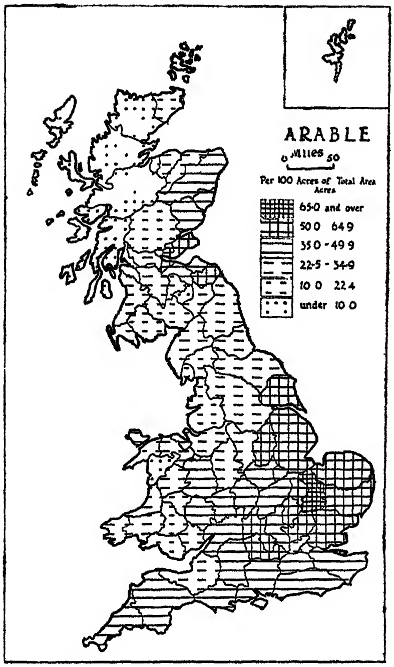


Fig. 5A

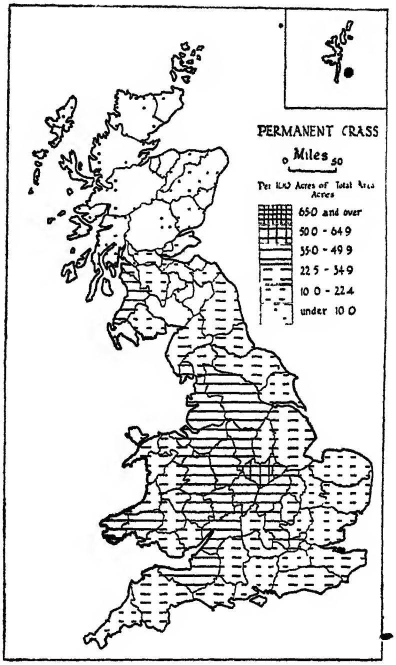


Fig 5B

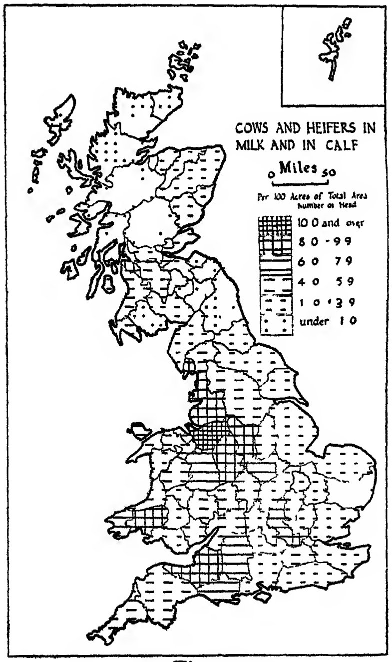


Fig. 5C

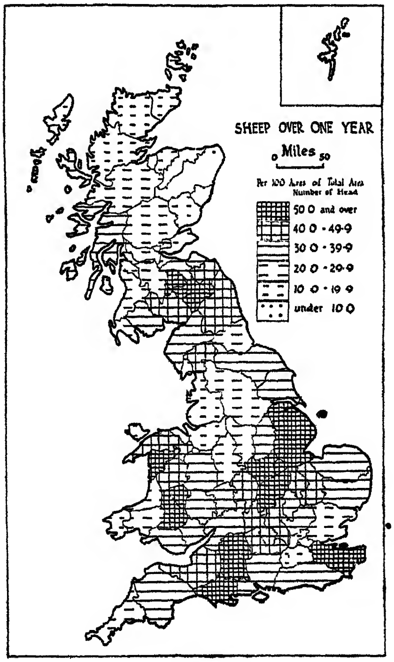


Fig. 5D

AGRICULTURE IN 1870 BY COUNTIES. I.

arable. Oats showed the reverse regional emphasis. In many counties of the English Plain less than 10 per cent of the arable was sown with oats and, with very few exceptions, those western counties which had under 20 per cent of their arable in wheat had over 20 per cent of their arable in oats. The influence of the cooler climate of the north and of the wetter climate of the west is clear. These northern and western districts had grown little wheat at all during the Middle Ages, but wheat, increasingly entering into the national dietary, had spread into them with the development of commercial farming. Of the roots, potatoes were relatively more important in the west, as they had been from their first introduction, and turnips relatively more important in the east, but roots were no longer limited to light soils. Mangolds, more suited to heavy land, had an acreage exceeding turnips and swedes only in Essex, though they were being grown increasingly. They were to increase much more later on in the century. Beans, though a declining crop, were still important on heavy lands within the English Plain, and they took up over 10 per cent of the arable in Bedford and Worcester. Even in a western district such as the Fylde in West Lancashire, they were sown on 6·7 per cent of the arable in 1870; the arable then included some of the clay loams now entirely under grass.[1]

In Scotland also there were distinctions between east and west. The eastern lowland counties of Aberdeen, Kincardine, Fife, the Lothians, and Berwick had over 40 per cent of their total area in arable, while the Western and North-western Highlands had under 10 per cent, but the climatic contrast was here heightened by a topographical and soil contrast. In the western parts of the Central Lowlands and of Galloway the amount of arable was not inconsiderable. The proportion of the arable under corn in Scotland was usually lower than in England (40·9 per cent, as compared with 55·1 per cent), and the proportion under rotation grass higher (38·4 per cent, as compared with 20·2 per cent). Scotland, as a whole, was, in this respect, more comparable to western England and Wales. The percentage under corn was, however, usually lower and the percentage under rotation grass usually higher in the western Central Lowlands and in Galloway than along the east coast from Aberdeen to Berwick, but the difference was not as pronounced as between West and East England. Throughout Scotland, wheat was the least important of all corn crops (3·6 per cent of the arable as compared

[1] W. Smith, 'Agrarian Evolution since the Eighteenth Century', *A Scientific Survey of Blackpool and District, Brit. Assoc. Reports* (1936), p. 49.

Fig. 6.—A is *Temporary, Grass*, B *Wheat*, C *Barley*, and D *Oats*, expressed in number of acres in each crop per 100 acres of total arable area in each county. Maps constructed from the *Agricultural Returns* for 1870. The scales of shading are identical in the four maps.

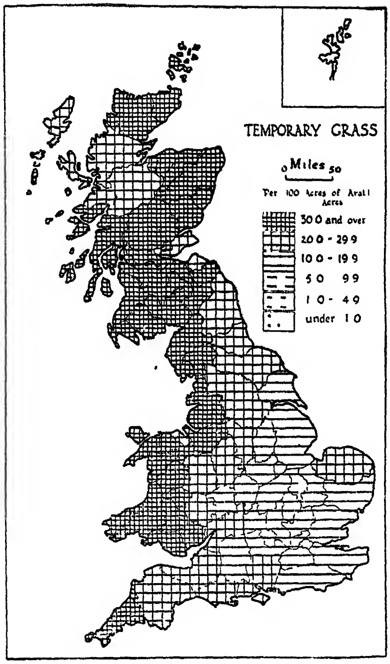


Fig. 6A

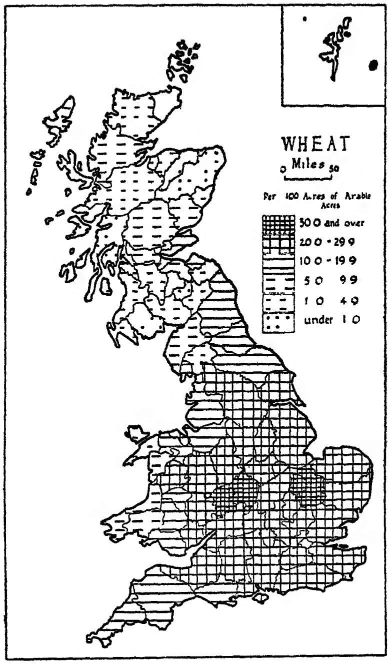


Fig. 6B

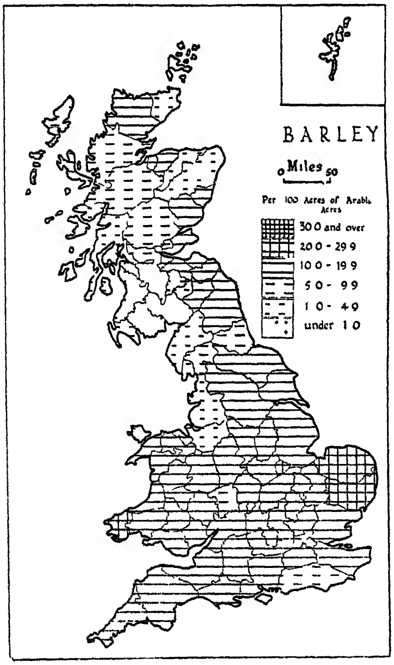


Fig. 6C

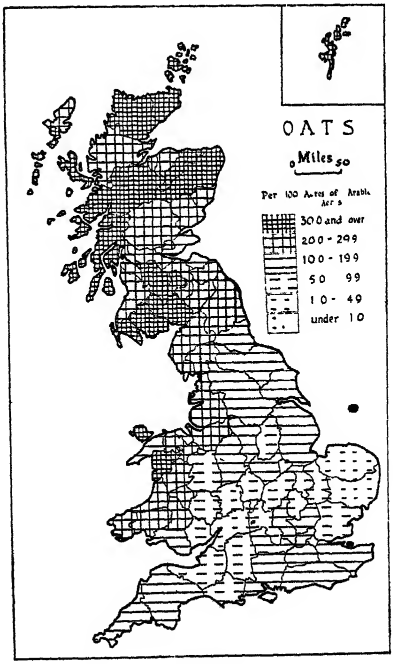


Fig. 6D

AGRICULTURE IN 1870 BY COUNTIES. II.

with 23·7 per cent in England), and it was really significant only in Fife and the Lothians, the most sunny parts of Scotland. In the Orkneys and Shetlands no wheat at all was grown. Everywhere the most important corn was oats, a clear reflection of the cooler and less sunny summers. Beans were unimportant except on certain carse soils. Roots were extensively grown: the yield per acre was high in the cool moist climate of Scotland, and they fitted in with the stock, always an important element in Scottish farming. The turnip acreage was greatest in the eastern arable districts, but potatoes were grown alike in Highland crofting communities, in the western Central Lowlands, and in the arable Lothians and Fife.

The Shetlands presented features distinct from the rest of Scotland. Two-thirds of the arable were under corn (oats and barley), a sixth under potatoes, and over a fifth in fallow. Only 5·8 per cent of the whole arable acreage was in turnips, rotation grass, and other crops. The turnip and clover husbandry, which had spread all over Scotland, was, even in 1870, practised on only a very limited scale in the Shetlands, the outpost. Potatoes were grown, as in all crofting communities, but more extensively here than in most. Shetland agriculture thus clearly retained many old features; the arable was concerned almost entirely with the growth of human food (oats, barley, potatoes) and still in large measure practised a rotation of several successive corn crops broken by an occasional fallow. The chief improvement introduced was the substitution of potatoes for much of the fallow. Stock food was almost entirely natural grass, but very little was made into hay and stock only survived the winter in low condition.

There were marked regional variations within Britain in stock as well as in arable farming (see Fig. 5). In Hampshire, Kent, Essex, and Suffolk there were fewer head of cattle per 100 acres than elsewhere: these were arable counties which kept few cattle in summer.[1] There were over fifteen head of cattle per 100 acres in Lancashire, Cheshire, Derby, Stafford, and Salop; in Somerset and Cornwall; in Anglesey, Carmarthen, and Pembroke; in Buckingham; and in Leicester, Northampton, and Rutland. The first three groups are western counties with ample grass, a product of both soil and climate, and they include much lowland country. In the north-western group the cattle were mainly dairy cows. In Somerset, Carmarthen, and Buckingham, dairy cows were also more numerous than the other categories of cattle. But in Anglesey, Pembroke, and Cornwall, western peninsulas remote from the centres of consumption, young cattle were as numerous as dairy cows: these were rearing rather than

[1] The agricultural returns refer to conditions in June and cattle-fattening in the arable counties is a winter business, lean or forward stores being bought in in autumn. In recent years the Ministry of Agriculture has occasionally taken a winter stock census to obtain this supplementary information.

the beef Aberdeen-Angus. The eastern arable districts had comparatively few sheep, many fewer than the arable districts of England. Beef cattle were their chief stock. The western part of the Central Lowlands had more sheep and usually more than the western lowlands of England. But the chief sheep districts in Scotland were the Southern Uplands, with densities very similar to those of upland Wales and, to a lesser extent, the Highlands, where sheep were now more important than cattle, especially when equated with cattle as grazing units. The old cattle economy of the Highlands had largely gone and the sheep flocks, which were spreading north at the end of the eighteenth century, had by 1870 become general.[1]

H. Rider Haggard made a tour of most of the counties of the English Plain in 1901–2. The trough of corn prices had been reached in the 'nineties and everywhere he found depression among English arable farmers, great reductions in rent, and the laying down of arable to grass.[2] On strong lands, notably in Essex, there were derelict farms. These heavy soils were essentially wheat and bean land and the collapse of corn prices, greatest in wheat, affected them severely. In the grass districts agricultural depression was not so severe. In North Wiltshire the rental of the arable had fallen 50–60 per cent, but of the grass 15–20 per cent.[3] In Salop conditions were similar. The complaint in the grass districts was not of low commodity prices, but of the shortage of labour. This difficulty of obtaining agricultural labour was general in all districts, arable and grass alike. It limited, if it did not prohibit, farming 'in detail'. The tendency was more and more to 'skim over' the land, to reduce costs, and, as an inevitable consequence, to reduce yield also. In Salop the small farm, under 50 acres, small enough to be worked by family labour alone, continued to pay rent at the old level. It was the larger farm, requiring hired labour, whose rental had fallen The shortage of labour was, of course, the result of the rural depopulation which had been proceeding since the middle of the nineteenth century. It was a product of the mobility of labour, consequential on the disappearance of the common-field system, and of the attraction of the towns, consequential on the Industrial Revolution. The workshop rather than the farm had come to dominate the British economy and to attract the British labourer.

The course of rural depopulation during the nineteenth century has been analysed by Prof. P. M. Roxby.[4] The rural population in 1851 had grown far beyond that of 1801, but it began to decline slightly after 1851 and rapidly after 1871. The decline was not

[1] There is an excellent series of essays on agriculture at the time in the *Journal of the Royal Agricultural Society* for 1878.
[2] H. Rider Haggard, *Rural England* (1906), 2 vols.
[3] Haggard, op. cit., vol. 1, p. 28.
[4] P. M. Roxby, 'Rural Depopulation in England during the Nineteenth Century', *The Nineteenth Century and After*, no. 419 (1912), pp. 174–90.

arrested until the first decade of the twentieth century. This rural depopulation was not, however, uniform. It varied substantially from district to district with the type of farming, which in its turn depended on the qualities of the environment. In other words, it varied geographically. Table V abstracts some of the figures from this analysis in order to show the course of change in a number of different arable districts. Each area was purely rural and the significance of the figures is not vitiated by the inclusion of any extraneous urban population. It is clear that since 1871 the decline was substantial in districts practising 'standard' arable farming, but it was greater on the heavier than on the lighter soils. In the fruit and market gardening districts population, in contrast, either remained steady or actually increased. Evesham, which registered a progressive increase of rural population, had a favourable geographical position and tenurial conditions very favourable to the small-holder.

TABLE V

Trends of Rural Population in England during the Nineteenth Century in Selected Arable Districts

	1801	1851	1871	1891	1911
Kimbolton (Hunts.) . *Clay land arable*	5,934	9,339	9,126	6,836	6,141
Bungay (Suffolk) . . . *Light land arable*	4,597	6,539	6,331	5,803	5,456
Evesham (Worcs.) . . *Fruit and vegetables*	5,048	7,696	8,324	9,112	12,307
Spalding (Lincs.) . . . *Fruit and vegetables*	10,751	22,388	23,184	21,733	23,497

From P. M. Roxby, *The Nineteenth Century and After*, no. 419 (1912), p. 177

Although Rider Haggard demonstrated the unprofitability of 'standard' types of farming, he did not fail to visit new kinds of farming enterprises. The importance of the new types of farming was underlined by E. A. Pratt in a book to which he gave the significant title *The Transition in Agriculture*.[1] The burden of Pratt's argument was that, as cereal-growing had proved unprofitable owing to the competition of virgin colonial land, British farming should devote itself increasingly to the production of the more diversified articles of food, the demand for which was increasing with changes in diet owing to the rising standard of living; that is, to milk, eggs, poultry, green vegetables, fruit. He drew an industrial analogy from the Birmingham district which had turned from heavy standard iron and steel production to the lighter metal trades.[2]

The urban demand for milk had continued to grow. Morton had estimated in 1878 that the average *per capita* consumption for the

[1] E. A. Pratt, *The Transition in Agriculture* (1906). [2] Pratt, op. cit., p. 323.

whole country was 0·25 pint per day.[1] A report of a committee of the Royal Statistical Society in 1904 was to the effect that the average consumption of whole milk in the United Kingdom per head was 15 gallons per annum,[2] which works out at 0·33 pint per head per day. It thus appears that the consumption per head was increasing and, as the total population (especially the urban population) of the country was increasing also, the rise in the total requirements of milk was substantial. The dairy herd had increased considerably and the yield per cow had probably increased also. This increasing urban demand for milk was met by an expansion of the radius from which fresh milk was drawn. The railway carriage of whole milk was increasing on almost every railway system. On the Great Western, which handled more milk than any other company, it had doubled in a decade.[3] While almost every town obtained some of its milk by rail, the greater part of the rail-borne milk went to London, which drew in its supplies from the Home Counties, the East Midlands, the middle Trent Valley, North Wiltshire, and, in smaller quantities, even from as far afield as Cheshire and Cornwall. Many of the districts supplying milk to the towns were ancient dairying districts which were selling whole milk instead of, as formerly, making it into butter and cheese. But the Essex clays, too expensive to work for wheat at 30*s*. or under per quarter, had been occupied by Ayrshire dairy farmers, who were creating a new dairy district on derelict land. The London Clay did not, however, make good grassland owing to its tendency to burn up in the summer, for the effective rainfall is here the lowest in Britain and dairying, then as now, was partly on the basis of arable cropping. Dr. Willatts has demonstrated a substantial substitution of grass for arable on the London Clay in other parts of the London Basin.[4]

The increasing production of fruit and of market garden crops was equally striking. In some districts, in the Fens, the Lothians, along the Ayrshire coast,[5] or South-west Lancashire, market-garden crops were grown in the ordinary course of arable cultivation in rotation with grain and temporary grass; but in other areas, usually much smaller in extent though intensively cultivated, land was withdrawn from grass or standard arable cultivation and devoted entirely

[1] R. H. Rew, 'Observations on the Production and Consumption of Meat and Dairy Products', *Journal Royal Statistical Society* (1904), p. 418.

[2] 'Third Report on the Production and Consumption of Meat and Milk in the United Kingdom', *Journal Royal Statistical Society* (1904), p. 391.

[3] Pratt, op. cit., p. 11.

[4] E. C. Willatts, 'Changes in Land Utilization in the South-west of the London Basin, 1840–1932', *Geographical Journal*, vol. LXXXII (1933), pp. 515–28. His comparison is of the tithe maps of *c.* 1840 and the Land Utilisation Survey of 1931–2. Some of the substitution is post-1918.

[5] Some of the Ayrshire coastlands were cropped with potatoes annually when visited by Sir Daniel Hall in 1912 (A. D. Hall, *A Pilgrimage of British Farming, 1910–12* (1913), p. 394).

to specialist fruit and vegetable production. Such, to name a few outstanding areas, were the Vale of Evesham, the Biggleswade and Sandy district of Bedford, the Wisbech district of the Fens, Kent, Blairgowrie, and the Carse of Gowrie, Holt in Denbigh, Ashton Moss and Irlam Moss in Lancashire, West Cornwall. Most of these had suitable soil and, in several cases, suitable climate, particularly for early spring production. But the intensively cultivated market garden often created its own conditions of soil and climate. A market garden soil was frequently a 'made' soil by reason of the vast quantities of manure added to it, and in glass-house cultivation (which, following the Guernsey pattern, was rapidly increasing) the air temperature and the soil moisture were capable of manipulation to any requirement. The celery growers of Ashton Moss and Irlam Moss had made their own soil with town manure and the forced-rhubarb growers of the outskirts of Leeds had made their own climate in darkened and heated forcing-sheds. It was, of course, only the intensively cultivated market gardens growing high-priced crops which could afford so to transform the physical environment to specification, and not all market gardening was as intensive or as specialized as this. Market gardening and fruit growing, implying more intensive uses of the land, required special tenurial conditions (such, for example, as the Evesham Custom), and, producing perishable commodities, required easy access to large urban markets, either by physical proximity or by good railway services. Where these conditions were absent, market gardening or fruit growing (except for cider-making) did not develop on any considerable scale.

By 1913, the real economic terminus of the nineteenth century, the reactions of the changed economic conditions—the relative unprofitability of cereal-growing and the relative profitability of the newer forms of agricultural enterprise—on the agricultural geography of Britain were already considerable. It is possible to measure them statistically by a comparison of the agricultural returns for 1870 and 1913.[1] Calculated as percentages, these are set out in Appendix A. The 1913 returns have been mapped in Figs. 7 and 8.

In every county of Great Britain there was a decrease in the arable acreage. It was comparatively small in Scotland (5 per cent), but in England it amounted to one-quarter and in Wales to over one-third. In 1870 England had had 58·6 per cent of the total cultivated land in arable; in 1913 it had 57·5 per cent in permanent grass. The balance of the agricultural economy had changed. Wales had been

[1] These are not strictly comparable. The 1870 statistics have no return for rough grazings. In most counties the area of cultivated land (arable + permanent grass) had increased by 1913, but it cannot be determined whether this represented a real increase in the extent of the improved land or simply greater completeness in the returns.

predominantly pastoral even in 1870. These averages, however, mask considerable regional differences. In the English arable districts the decline was comparatively small: this was true not only of East Anglia, but also of the intensively farmed arable district of South-west Lancashire and North Cheshire. These were mostly areas of light soil. But on the heavy soils of the east, such as Essex, and of the Midlands, such as Leicester, and in the western counties generally including Wales, the decline was substantial. In Scotland most of the eastern arable districts had an arable acreage that was stationary or had declined but little. The western parts of the Central Lowlands and the Southern Uplands showed more substantial decreases.[1] The decrease in arable was thus mainly in the non-arable districts, in western areas and, within the English Plain, on the clays. These could satisfactorily be laid down to grass. But those arable districts which were of light soil were not convertible to the same degree: they were not so suited to grass and had perforce to remain largely in arable or lapse to rough heath.

The abandonment of arable and the laying down to grass was one of the most obvious adaptations to the economic situation, but there was also a widespread substitution of crops in the arable that remained. In the light soil arable districts of the English Plain the modifications in the general character of the rotation—the proportion of the total arable in corn, in rotation or temporary grass, and in root and green crops—were at their minimum. Changes were much more substantial on the Midland clays and in the western districts. The most general feature of change here was a decrease in the proportion of the arable in corn and an increase in the proportion in temporary grass. The long ley was no new feature of the arable rotations of Wales and of western England: it was an adaptation to the climate and it was now also an adaptation to the economic situation. It was an alternative to laying the land down to permanent grass, a movement active in these western districts as shown in the preceding paragraph, and some, in fact, returned as temporary grass ultimately became permanent grass.[2] In Cheshire, Radnor, Pembroke, and Westmorland the proportion of the arable under rotation grass was by 1913 one-third or over, and in Cornwall it was nearly

[1] Most of the counties north of the Highland Line (except Shetland) displayed actual increases. These same northern counties registered also increases in the acreage of permanent grass, usually greater than the increases in arable. Either rough grazings were being improved substantially or the returns were becoming more complete.

[2] On the statistical basis for this, see J. A. Venn, *Foundations of Agricultural Economics* (1923), p. 366.

Fig. 7.—A is *Arable*, B *Permanent Grass*, C *Cows and Heifers in Milk and in Calf*, D *Sheep over one year*. A and B are expressed in number of acres, C and D in number of head, in all cases per 100 acres of total agricultural area of each county. Maps constructed from the *Agricultural Statistics* for 1913. The scales of shading are identical with those in the corresponding maps in Fig. 5. See notes under Fig. 5.

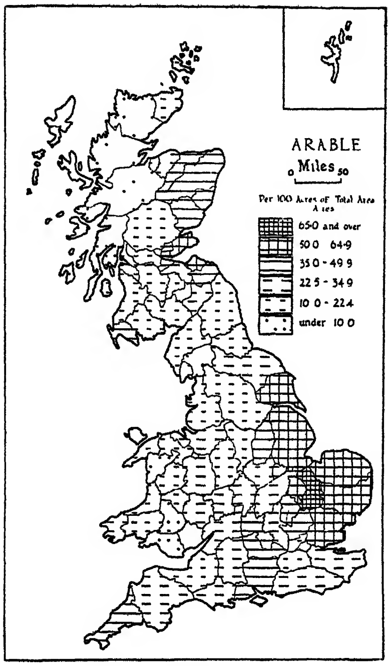


Fig. 7A

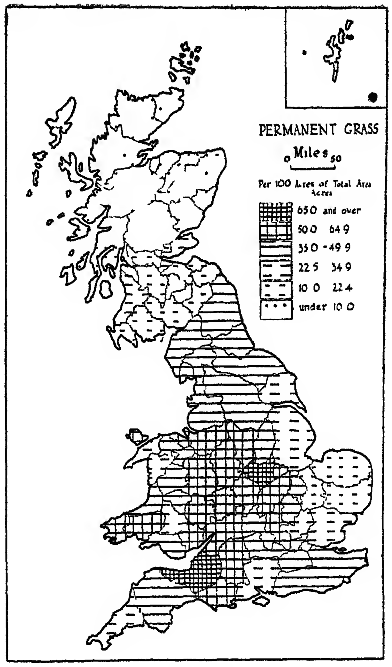


Fig. 7B

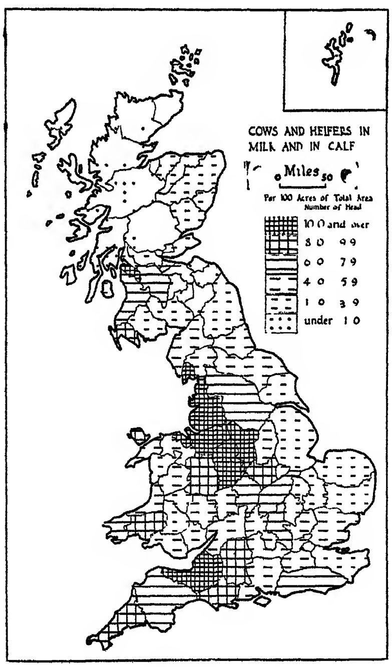


Fig. 7C

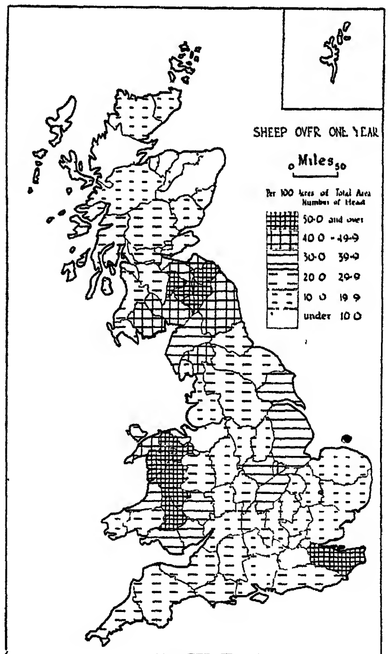


Fig. 7D

AGRICULTURE IN 1913 BY COUNTIES I.

one-half. In the eastern arable districts changes within the arable mainly took the form, not of alterations in the rotation, but of the substitution of one crop for another of the same kind. Although the proportion of the arable under corn remained steady, the proportion in wheat declined and in oats increased. Wheat had suffered most from the collapse of corn prices owing to foreign competition. Beans, grown extensively only on heavy land, almost everywhere declined. The proportion of the arable under root and green crops did not change substantially, but almost everywhere part of the turnip acreage was being sown with mangolds and the acreage in potatoes was increasing. The decrease in turnips and the increase in mangolds was correlated with changes in the proportion of sheep and of dairy cows, as will appear later. In Scottish arable districts a decline in the proportion under corn and an increase in the proportion under rotation grass, long a well-marked feature of Scottish arable farming, was more general. The acreage under all classes of corn declined. Scotland had never grown much wheat and by 1913 the wheat acreage had fallen to 1·7 per cent of the total arable. Even oats also declined in some counties, though to a lesser extent. Shetland had lost many of the archaic features which it had still retained in 1870: there were more turnips, seed grasses and hay, and less fallow and corn. It was concerned less exclusively with the growing of human food and more with the growing of stock food, like the neighbouring counties of North-east Scotland.

Parallel with these changes in the balance of arable and grass and of crops within the arable, there were changes in the numbers of farm stock. The New Husbandry of the eighteenth century had produced food for man and beast and the changes in the arable economy at the end of the nineteenth century, which have just been traced, were in the direction of producing less food for man and more food for beasts. The increasing proportion of the arable under rotation grass and under oats both contributed to this end. Except perhaps in some hill districts, the number of dairy cows everywhere increased, and, in an even greater proportion, the number of young cattle under two years old.[1] The increase in the number of dairy cows was greatest in the dairying districts and least, both actually and relatively, in the arable districts. The increase in the number of feeding cattle was comparatively small,[2] and in most districts their

[1] The increase in Great Britain of dairy cattle (cows and heifers in milk and in calf) in 1913, as compared with 1870, was 24·7 per cent and of young cattle under two years old, 50·9 per cent.

[2] Other cattle over two years old were 5·0 per cent more than in 1870.

Fig. 8.—A is *Temporary Grass*, B *Wheat*, C *Barley*, D *Oats*, expressed in number of acres of each crop per 100 acres of total arable area in each county. Maps constructed from the *Agricultural Statistics* for 1913. The scales of shading are identical in the four maps and with those of Fig. 6.

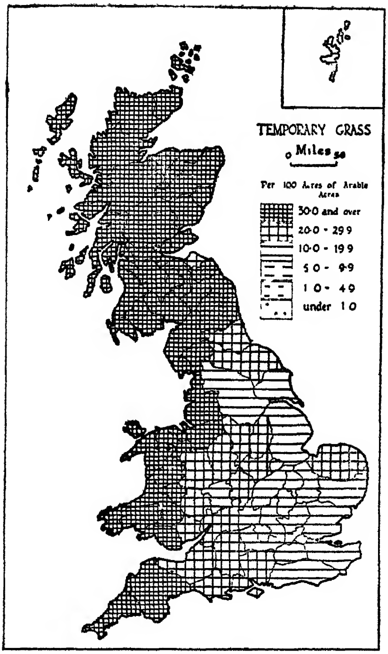


Fig 8A

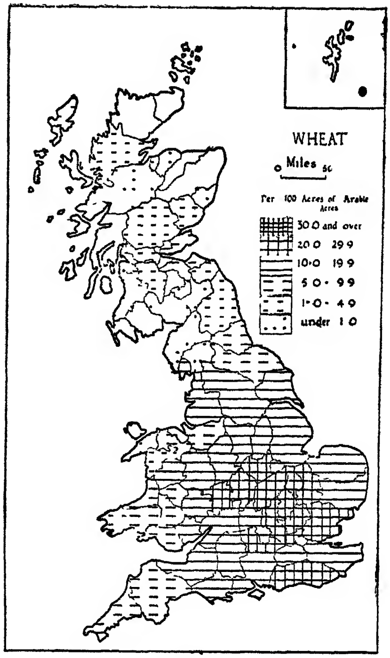


Fig. 8B

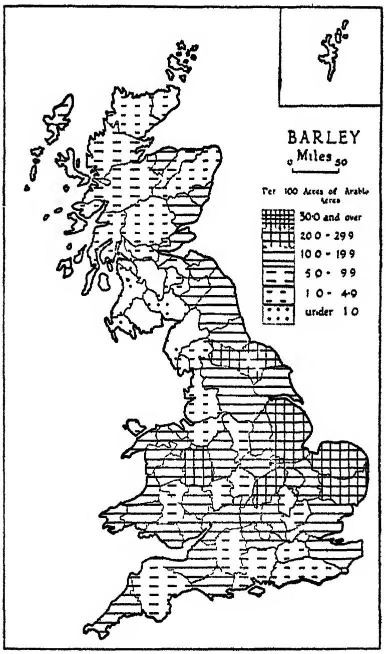


Fig. 8C

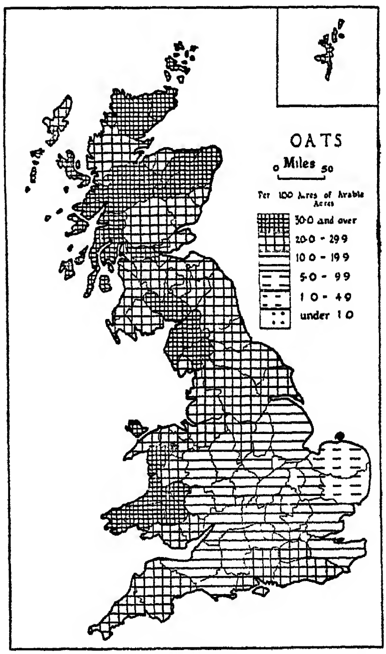


Fig. 8D

AGRICULTURE IN 1913 BY COUNTIES. II.

numbers were stationary or declined slightly. It was only in the arable feeding districts[1] (Norfolk, the Lothians, Aberdeen) and in the specialist grass-feeding districts (Leicester and Northampton) that increase was encountered. There were even more striking changes in the numbers and geographical distribution of sheep. One general change was an increasing ratio of lambs to adult sheep, explicable partly by a higher lambing percentage and partly by the slaughter of wethers at a younger age than formerly.[2] There was a marked decline in the numbers of sheep in the arable districts of eastern England and in the lowland districts of the Midlands and of the west. The eastern arable districts were substituting cattle (of all ages and classes) for sheep and were growing more mangolds and less turnips. The lowland grass districts of the Midlands and of the west were becoming more completely cattle regions, feeding and dairying in the one case, dairying and rearing in the other. But in Wales and in the Northern Pennines there was a substantial increase in the sheep population. In Scotland even the arable districts showed an increase—sheep had not hitherto been as important here as in the English arable districts—but the increase was most marked in the Southern Uplands. Only the Western Lowlands of Scotland showed a stationary or slightly declining sheep population. It was clearly on the grassy uplands of Wales, the Northern Pennines, and the Southern Uplands that sheep were increasing. The lowland arable sheep were mostly large animals, the upland hill sheep small animals. By 1913 the size of the family had already begun to decline and the smaller joint was more suited to the smaller family unit. The hill sheep also gave sweeter mutton.

Many of these changes, outlined above, contributed to an increasing regional specialization of farming. The arable districts were remaining largely arable, the grass districts were becoming more completely under grass and devoting themselves more exclusively to *one* form of stock economy. This regional specialization was the result of the interplay of a complex of physical and economic factors, some of which have already been indicated in general terms and which will be analysed with more precision in Chapters IV and V. It was the response, on the agricultural side, to the specialist economy which developed in Britain during the nineteenth century, in industry even more than in farming.

[1] The statistics refer to June and, as arable feeding is a winter business, these statistics do not necessarily give a correct impression.

[2] The number of sheep over a year old had increased by 15·9 per cent, but the number of lambs by 47·4 per cent.

CHAPTER II

INDUSTRY

I

THE MIDDLE AGES

THE Middle Ages was a period of self-sufficiency in industry as well as in agriculture. Clothing and tools were manufactured, just as corn was grown, at the point of consumption, but the geographical unit of self-sufficiency was the region rather than the village. Some of these manufactures were the product of part-time household industry,[1] others the work of craftsmen. It is probable that the first preceded the second,[2] but specialist craftsmen were already established by the twelfth century,[3] though both persisted, and still persist, side by side. By the thirteenth century, the point at which this survey of the antecedents of the modern economic geography of Britain begins, the specialist crafts were to a considerable extent concentrated in the towns. This, however, implied little modification of regional self-sufficiency. The town crafts produced simply for the locality and regarded the local region as their natural area of monopoly. Most medieval master craftsmen were retail traders or shopkeepers, as well as manufacturers: they sold direct like the producer-retailer dairyman of to-day. There was only a limited regional specialization of industrial production, for the same kind and range of consumption goods were produced and consumed in each region.

But manufacturing production was not limited to the urban centres.[4] Lipson records a Leicester gild regulation of the thirteenth century which he takes to be a measure of defence for the Leicester town craftsman against the country weaver in the villages near by.[5] There was country weaving and fulling in the West Country, though the towns probably dominated production here before the fifteenth

[1] The family system of Ashley's nomenclature (W. J. Ashley, *The Early History of the English Woollen Industry* (1887), p. 72).

[2] G. Unwin, *Industrial Organization in the Sixteenth and Seventeenth Centuries* (1904), pp. 1–2. Household industry persisted into centuries long subsequent to the medieval. There was household brewing in the North of England in the latter half of the nineteenth century and household baking in the twentieth. But these are consumption rather than manufacturing industries, and to-day produce for a regional market.

[3] E. Lipson, *Economic History of England*, vol. 1, pp. 365–6. Craft gilds were mentioned in a pipe roll of the reign of Henry I.

[4] Lipson doubts whether membership of craft gilds was in all cases strictly confined to those resident within the town.

[5] Lipson, op. cit., p. 444.

century;[1] and Prof. Heaton[2] shows that in Yorkshire, although York and Beverley were the largest individual woollen working centres, there were thirteenth-century cloth workers throughout the present West Yorkshire textile district, in the Vale of York and in some of the Pennine dales in addition. There was thus a rural as well as an urban distribution of cloth workers,[3] but, except probably for blacksmiths and some few others, this may not have been true of other industrial crafts. Mining and smelting had, of course, entirely a rural distribution. After this general statement, the industrial geography of the Middle Ages will now be considered item by item.

The most important industry was the woollen and worsted. Sheep were kept in most vills and as wool producers, though not as producers of meat, they could be kept successfully on the commons and on the stubble, the pasture available to the medieval grazier. Wool was not only a by-product of mixed farming practice, but was also the chief object of much monastic farming. Thus extensively produced, wool was a clothing material appropriate to the climate. In the form of raw wool it was the chief export of the country and was sent across to the Low Countries, from which in the early Middle Ages some was transhipped overland to Italy. English wool was the best in Europe.[4] England was then largely contributory to more advanced industrial centres elsewhere, much as the Argentine or Australia are to-day. Concurrent with wool export abroad, there was, however, woollen manufacture at home. It supplied the greater part of the consumption needs of the country and, although finer cloths were imported, they were mainly for the court, the nobility, and the wealthier merchants. There was indeed a substantial export of cloth abroad. In the early part of the Middle Ages export of wool greatly exceeded export of cloth, but by the middle of the fifteenth century the export of cloth (reckoned in terms of wool equivalents, $4\frac{1}{3}$ cloths to 1 sack of wool) had grown to exceed the export of raw wool.[5]

There is specific information on the geographical distribution of the woollen industry during the Middle Ages from the aulnage accounts. These have been printed in summary form for three periods, 1353–8, 1394–8, and 1468–73.[6] The aulnage accounts[7] were

[1] R. H. Kinvig, 'The Historical Geography of the West Country Woollen Industry', *Geographical Teacher*, nos. 44 and 45 (1916), p. 244.

[2] H. Heaton, *The Yorkshire Woollen and Worsted Industries* (1920), pp. 5–7.

[3] *The Little Red Book of Bristol*, folio 120. Such rural fulling was considered to be of inferior quality.

[4] H. Pirenne, *Economic and Social History of Medieval Europe* (1936), p. 37, and E. Power, 'The Wool Trade in the Fifteenth Century', Power and Postan, *Studies in English Trade in the Fifteenth Century* (1933), p. 39.

[5] H. L. Gray, 'English Foreign Trade, 1446–82', Power and Postan, op. cit., pp. 10–11 and 362.

[6] For 1353–8 and 1394–8 by H. L. Gray, 'The Production and Exportation of English Woollens in the Fourteenth Century', *English Historical Review*, vol. XXXIX (1924), p. 34; for 1468–73 by Heaton, op. cit., p. 85.

[7] The aulnager was an official appointed 'to enforce the assize of cloth as fixed

not a census of production in the modern sense; they excluded worsteds, coarse cloths, and pieces woven in the household for household use, and they registered therefore much less than the total production of the country. But they give an approximate idea of the relative magnitude of *woollen weaving* in different parts of the country. It must be noticed that they do not necessarily indicate the distribution of woollen spinning, a household craft performed largely by women and children and, though carried on mainly in the

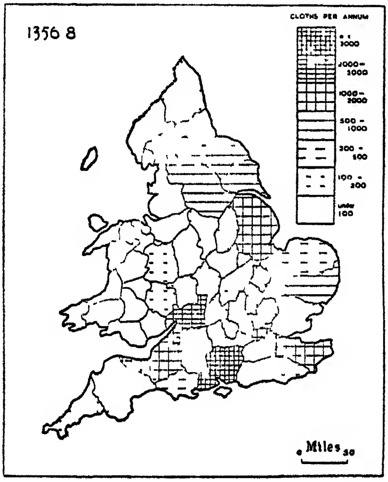


Fig 9A

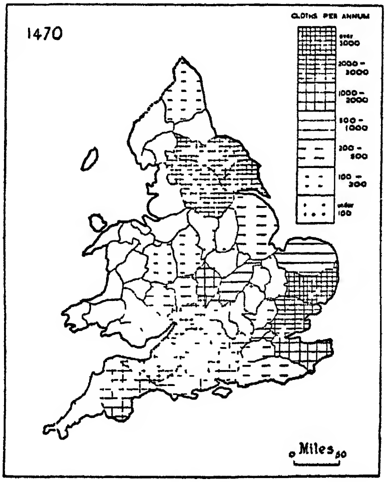


Fig. 9B

PRODUCTION OF WOOLLEN CLOTHS IN EACH COUNTY OF ENGLAND IN THE FOURTEENTH AND FIFTEENTH CENTURIES

According to the Aulnage Accounts for 1356–58 (A) and 1470 (B). In number of cloths of assize per county per annum, irrespective of size of county. Scale identical in the two maps. Maps drawn from abstract of Aulnage Accounts in H. L. Gray, *English Historical Review*, vol. XXXIX (1924) and H. Heaton, *Yorkshire Woollen and Worsted Industries* (1920). Where cloths were smaller than a cloth of assize, they were reckoned in equivalents of a cloth of assize.

same towns and rural districts as weaving, was not necessarily confined to these. The aulnage accounts are mapped county by county for 1356–8 and 1470 in Fig. 9 as actual quantities; and percentages for regional groups of counties calculated for 1356–8, 1394–8 and 1468–73 are set out in Table VI.

Though they must be accepted with some reservations because of the limitations of the accounts as a census of production and because of the untrustworthiness of some of the returns,[1] some very

by the government of the day, and to collect the subsidy levied on cloth manufactured for sale' (Heaton, op. cit., p. 127).

[1] It has been shown that some of the fifteenth-century accounts were unquestionably 'cooked' (E. M. Carus-Wilson, 'The Aulnage Accounts: A Criticism', *Economic History Review*, vol. II (1929), pp. 114–23).

interesting conclusions may be drawn. In the middle of the fourteenth century the urban distribution of woollen weaving was clearly marked. The production of ten towns, according to the generalized calculations made by Prof. Gray,[1] amounted to approximately 9,000 cloths of a total production of 16,000. The most important towns were Salisbury, Bristol, London, and Winchester. From Table VI it is clear that South-east England, the metropolitan district including London and Winchester, was the most productive single region. The West Country (Gloucester, Somerset, Wiltshire, Dorset, Devon, and Cornwall) was the second, and, following far behind, were East Anglia and Yorkshire. But East Anglia made more worsteds than woollens and, if these be added, it was probably not far behind the West Country. By the end of the fourteenth century the changes in distribution were considerable. The proportion of the total production which came from the ten towns had fallen to one-half.[2] The urban domination of the clothing industry was beginning to pass away. The south-east, the metropolitan region, had declined both actually and relatively. It was now surpassed by both the West Country and, if worsteds also be taken into account, by East Anglia. In the metropolitan region manufacture had been largely urban, in the West Country and East Anglia it was becoming partly rural. The country districts were outside gild control and already had numbers of capitalist clothiers.[3] By the second half of the fifteenth century these changes had proceeded further. The metropolitan district continued to decline, East Anglia and Yorkshire continued to grow, and, although the share of the West Country in the total production was less than at the end of the fourteenth century, it was greater than in the middle of that century. In Yorkshire, which offered a mirror of the local changes proceeding elsewhere, the number of cloths annually attributed by the aulnage accounts to York was approximately 3,200 in 1394–5 and 1,170 in 1473–5, and to West Yorkshire (the present-day woollen and worsted district) 290 in 1396–7 and 1,290 in 1473–5.[4] The decay of the town and the rise of the country manufacture was striking. These changes in the geographical distribution of the industry, though in progress during the fourteenth and fifteenth centuries,[5] were to become more pronounced during the sixteenth. A discussion of the causes of these changes in distribution, of the relationship of the regional manufacturing districts to their local environment, and of the differences in type of fabric woven within them, will accordingly be deferred.

There were important leather-working 'misteries' based, like

[1] Gray, *English Historical Review*, vol. XXXIX, p. 22.

[2] Gray, *English Historical Review*, vol. XXXIX, p. 32.

[3] Lipson, op. cit., pp. 469–70.

[4] Heaton, op. cit., pp. 60, 70–1, 75.

[5] The beginning of rural fulling can be placed in the thirteenth century (E. M. Carus-Wilson, 'An Industrial Revolution of the XIIIth Century', *Economic History Review*, vol. XI (1941)).

clothing, on the beasts of the farm. Both issued out of the agricultural basis of medieval Britain and particularly out of the pastoralism characteristic of northern and western districts. The leather crafts were widely distributed,[1] for they served a local market: hides were worked into shoes, sheep- and deerskins into gloves, points or laces, and the like. A surplus of hides was available for export, especially from Wales, but, like that of wool, export diminished towards the end of the Middle Ages.[2]

TABLE VI

Distribution of Woollen Production by Districts in the Middle Ages

	1356–8	1394–8	1468–73
Metropolitan South-east	46·6	11·1	10·7
West Country	28·3	52·8	39 4
East Anglia	5·8	11·4	22 6
Yorkshire	5·4	8·7	12·6
Others	13·9	16·0	14·7
	100·0	100·0	100·0

Calculated from H. L. Gray, *English Historical Review*, vol. xxxix (1924), and H. Heaton, *The Yorkshire Woollen and Worsted Industries* (1920).

There were metal crafts in addition to those based on agricultural materials. Certain of these were inevitably localized mainly in the metropolitan centre, goldsmiths and silversmiths being examples. The pewterers, making household ware, were more widely dispersed: London was their first, York their second, centre. Bell-founders were in many towns, particularly ecclesiastical centres such as London, Gloucester, York, Canterbury, Bury St. Edmunds, Norwich; and the Middle Ages, with numerous parish churches and monastic houses, provided a large market for their wares. Cannon, employed from the early fourteenth century onwards, were made largely in the towns at first, but by the end of the fifteenth century the craft had become established, among other places, in the Weald, near the metropolitan centre, and in a smelting district.[3]

The medieval references to the use of coal are obscured by terminology: 'carbo' and 'cole' both meant charcoal, and it was only when 'cole' had a prefix (as sea-cole or pit-cole, to denote its origin, stone-coal, its appearance, or smithy-coal, its use) that the obscurity is resolved.[4] The earliest indisputable references in Britain date to the thirteenth century, and these referred to the following fields—

[1] L. F. Salzman, *English Industries of the Middle Ages* (1923), p. 246.

[2] Dr. Pelham gives a map showing the relative quantities of hides exported from eastern ports, 1282–90 (R. A. Pelham, 'Medieval Foreign Trade: Eastern Ports', *An Historical Geography of England before 1800*, ed. by H. C. Darby (1936), p. 315).

[3] Salzman, op. cit., p. 163.

[4] J. U. Nef, *The Rise of the British Coal Industry*, vol. I (1932), pp. 4–5; and Salzman, op. cit., p. 2.

the Lothians, Northumberland, South Yorkshire, South Wales, and the Forest of Dean in the first half of the century; Nottinghamshire, Salop, Lancashire, Bristol, Staffordshire, Warwickshire, Derbyshire, and Fife in the second half. Almost every coalfield was involved, though it must be remembered that many of these references refer to almost infinitesimal quantities and that regular mining was not in every case implied. It was only along the Tyne that coal-working attained any substantial proportions; even here the export per annum did not exceed 7,000 tons in the most favourable year, and there is no indication that it increased between 1377 and 1514.[1] The market was small and it was not expanding. Smiths employed coal regularly in their rougher work for reheating pig and bar iron, but it was only smiths who worked on the coalfields or in London. Lime-burners also used coal occasionally. The limitations to its use were an abundance of alternative fuel, its unsuitability as a domestic fuel in the chimneyless houses of the Middle Ages, the high cost of transport for such a bulky commodity,[2] and the fact that the coal-fields lay mainly in the remote and scantily peopled northern and western districts of the country. 'Except for the Tyne valley,' says Nef, 'there was no district from which, until after 1500, the new fuel was regularly carried in quantities of more than a few hundred tons per annum, for distances of more than a few miles from the outcrops.'[3] The pre-eminence of the Tyne must have been due to the cropping out of coal close to the coast and the estuary, coupled with the position of the coalfield in the eastern, and economically most developed, part of Britain.

The mining of iron, lead, and tin, though localized in fewer areas, contributed more substantially to the economic geography of the Middle Ages. Iron was in constant demand for farm implements, domestic utensils, and 'engines of war'; lead for church roofs and piping; tin for currency and metal ware. There was iron-mining in the twelfth century in West Cumberland, in the dales of North-east Yorkshire, in Derbyshire, but especially in the Forest of Dean. In the thirteenth century, Furness, Northampton, but above all the Weald, were added, and at later times other areas in the Pennines and West Midlands.[4] Most of the orefields of England were thus affected, whether bedded ores in the Hastings Beds, the Jurassic or the Coal Measures, or irregular haematite ore bodies in Furness and West Cumberland. Most, if not all, of these areas were heavily wooded. Iron was obtained on the bloomery hearth by hammering the ore (mixed with marl and lime), rendered pasty and malleable by heating with charcoal, of which enormous quantities were consumed.

[1] Nef, op. cit., vol. 1, pp. 9–10.

[2] 'The charge for Newcastle coal in London, even though the shipmasters took it as ballast, was rarely less than three or four times the price on the Tyne' (Nef, op. cit., vol. 1, p. 13).

[3] Nef, op. cit., vol. 1. p. 8.

[4] Salzman, op. cit., pp. 23–8.

Salzman quotes a consumption in the mid-sixteenth century of 2·7 million cubic feet of timber in under two years by two smelting furnaces, each with a forge attached.[1] The earliest bloomery hearths were placed on windswept hills (the 'boles' of Derbyshire and Yorkshire),[2] but these were uneconomical and left slag containing a high residue of iron.[3] During the nineteenth century old slag from the Forest of Dean bloomeries was resmelted at the rate of 1 ton of slag to 1 ton of raw ore. The use of foot-bellows increased the blast, and in the fifteenth century bellows were attached to water-wheels. In these furnaces with a created blast the ore was smelted and the molten iron drawn off and cast in beds of sand. This was pig iron as distinct from bloomery iron. Forges associated with these improved smelting furnaces sometimes had hammers driven by water-power. The North of England centres appear to have served mainly local markets, but the South of England was supplied first from the Forest of Dean and later from the Weald. The Forest of Dean had long been worked for iron and had the institution of 'free miners' who had their own courts. The Weald had the advantage of proximity to London.

The chief lead-mining districts were at Alston in Cumberland, in South Derbyshire, and on the Mendips, the country rock being Carboniferous Limestone in each case. The Cumberland and Derbyshire ores were being worked by the twelfth century, and the Mendip ores possibly also. Mining was in the hands of 'free miners', and the rules for prospecting and staking a claim were rigidly laid down. The lead veins of the Northern Pennines have their richest ores near the weathered outcrop, and in consequence the shallow mining methods of the Middle Ages presented no handicap.[4] The miners had prescriptive rights to timber for charcoal. Foot-bellows were used to provide a blast and in the fifteenth century, as in iron-smelting, bellows were driven by water-power. Tin-mining was confined to the South-west Peninsula, around the edges of Dartmoor and of the several moors of Cornwall. During the Middle Ages the greater part of the output was from alluvial deposits.[5] The institution of 'free miners' was here the most strongly entrenched of all mining districts. All smelted tin had to be sent to one of nine coinage towns, four of which were in Devon and five in Cornwall.[6] The wind-swept

[1] Salzman, op. cit., p. 39.

[2] S. H. Beaver, Discussion on G. S. Sweeting, 'Wealden Iron Ore and the History of its Industry', *Proc. Geol. Assoc.*, vol. LV, pt. I (1944).

[3] Analysis of bloomery cinder quoted by Sweeting (op. cit., p. 7) gives 53·4 per cent FeO. This high residue of iron was inherent in the process, for the iron did not become molten and so could not be run off. It was not necessarily an indication of an inefficient employment of the process.

[4] A. E. Smailes, *Geography*, vol. XXI, pt. II (1936), p. 124.

[5] G. R. Lewis, *The Stannaries* (1924), p. 8.

[6] Ashburton, Plympton, Tavistock, and Chagford in Devon; Bodmin, Liskeard, Lostwithiel, Helston, and Truro in Cornwall

uplands of Cornwall were relatively bare of timber, and it appears that coal was imported coastwise from South Wales; this imported coal may have been used to supplement the limited local charcoal.[1]

Most of this mining enterprise was within or around the edges of the Palaeozoic uplands of the north and west. Apart from the Wealden iron industry, mining was almost absent from the English Plain. The industrial geography of the Middle Ages in England and Wales thus exhibited two major provinces—the English Plain, with its town crafts and its clothing industries; the uplands of the west and north, with their mining. It was a distinction between two quite different types of enterprise—extractive mining and smelting closely localized by the provenance of raw materials, and finished manufacturing relatively mobile and independent of raw materials.

II

THE SIXTEENTH AND SEVENTEENTH CENTURIES

The regional industrial self-sufficiency of the Middle Ages, though never complete, was beginning to pass away before the end of the fifteenth century. The regional market was being replaced by the national market. The late Prof. Unwin gave a sixteenth-century illustration from the cap trade. 'The woollen caps . . . which had been among the leading products of local industry in every large town, were being gradually replaced during the sixteenth century, by more fashionable headgear from beyond sea, or by the new felt hats which were beginning to be made in London.'[2] Industries were developing in particular localities beyond the capacity of the local market to absorb their production and the localities wherein they developed were those which had some special advantages. Thus in Chester the decline of the cappers was balanced by the growth of the glovers, who worked up skins imported from pastoral Ireland, and for which industry Chester, by reason of its space-relations, had a natural geographical advantage. 'The decay of crafts,' says Unwin, 'was in fact due, not only to the growth of foreign commerce, but still more perhaps to the concentration of English industries in localities specially adapted to them.'[3] The generalized manufacture of the Middle Ages, whereby each town had samples of many crafts, was beginning to be replaced by the specialized manufacture of a narrow range of commodities in harmony with the qualities of the regional geographical environment. Defoe, in the early eighteenth century, remarked upon this change which by his time had proceeded further—'some other Towns, which are lately increas'd in Trade and Navigation, Wealth, and People, while their Neighbours Decay,

[1] Pelham, 'Fourteenth-century England', *An Historical Geography of England before 1800*, ed. by H. C. Darby (1936), p. 259.

[2] Unwin, *Industrial Organization*, p. 71.

[3] Unwin, *Industrial Organization*, p. 72.

it is because they have some particular Trade . . . inseparable to the Place, and which fixes there by the Nature of the Thing; as the Herring-Fishery to Yarmouth; the Coal Trade to New-Castle; the Leeds Cloathing-Trade; . . . the Virginia and West-India Trade at Liverpool; the Irish Trade at Bristol.'[1] Specialized regional manufacture, thus replacing the generalized urban manufacture of the Middle Ages, was to attain its most complete expression during the nineteenth century. It was the parallel in industry to the regional specialization of agricultural production whose progress has been traced in Chapter I.

This increasing regional specialization of industry was bound up with a second change. Though manufacturing industry continued to persist in the towns, they were ceasing, during the sixteenth and seventeenth centuries, to dominate the industrial geography. Industry was migrating from the town to the country districts, but, judging from unemployment reported in the towns, the industrial population was not migrating with it to the same extent. The process had begun in the woollen manufacture before the close of the Middle Ages. It did not, however, proceed without opposition. Legislation endeavoured to protect the established town industries and to check the growth of rural industries by means of both local and general Acts.[2] What were the causes of this rural migration of industry? It was due, firstly, to lower manufacturing costs in the country districts. The country craftsman was outside gild control (though there were many projects to regulate rural industry)[3] and was free from gild levies; country manufacture escaped the higher rating of the towns;[4] the cost of living in the country was lower, and unemployment bore less hardly on the country worker, who in many cases had an alternative source of income from the land. These factors had been present during the Middle Ages, but the powerful gilds had kept them in check. The rural migration of industry was due, secondly, to the increasing use of water-power and of timber and coal by industrial workshops. These were post-medieval or, at earliest, late-medieval. The overshot water-wheel,[5] requiring a weir or else a mill dam and a long conduit, involved a stream-side site which, in most cases, necessitated a rural situation. The introduction

[1] Defoe, op. cit., vol. I, p. 43. His examples might be open to criticism, but his point is a valid one.

[2] Such a general Act was that of 1554 to remedy decay in 'Cities Borowes Townes Corporate and Market Townes'.

[3] Unwin, *Industrial Organization*, p. 175; Unwin, *V.C.H. Suffolk*, vol. II (1907), pp. 254–71; Heaton, op. cit., Chapter VII.

[4] This was a not inconsiderable factor in the Middle Ages. In 1294 the tax was one-tenth of movables in the rural districts, but one-sixth in the towns; from 1332 it was one-fifteenth and one-tenth respectively.

[5] J. U. Nef, 'The Progress of Technology and the Growth of Large Scale Industry in Great Britain, 1540–1640', *Economic History Review*, vol. V, no. 1 (1934), p. 8. *The Survey of the Manor of Rochdale* of 1626 specifies 'a fulling mill . . . with damms water troughs, etc.' (Chetham Society), vol. LXXI, p. 159.

of large-scale industrial enterprises using coal or timber in quantity also necessitated a rural situation, where alone these fuels could be obtained in sufficient bulk.[1]

There was, thirdly, a substantial change in the size of the industrial unit. In the clothing industry the productive unit, it is true, remained small. Although the commercial unit in the form of the clothier[2] who put out work to individual combers, spinners, weavers, or fullers was frequently large, the industrial processes themselves were carried on largely in the home. This was the 'domestic system', though the term is unsatisfactory, as contrasted with the medieval gild system. But even in the clothing industries there were embryo factories containing a dozen hand-looms or more, and in these cases the system was not domestic in the sense that work was carried on entirely in the home. Such a factory was rarely built for the purpose and a pre-existing building was more often employed: a monastery[3] or a disused walk-mill.[4] In other industries the industrial, as distinct from the commercial, unit was often larger. One industrialist on the Wear (County Durham) claimed to employ 300 men in salt works in 1589.[5] Alum-making near Whitby employed some 80 men in each house, a Kentish cannon foundry employed 200 men in 1613, and a paper mill at Dartford some 'scores of hands'.[6] Some of these were driven by water-power, others used coal.[7]

There is not space to examine each industry in turn during the period between the Middle Ages and the Industrial Revolution. I will limit myself to samples—the wool textile and the iron, as samples of textile and metal manufacturing industries respectively.

The woollen and worsted continued to be the most important single industry in Britain. By the close of the Middle Ages three great regional centres had already emerged—the West Country, East Anglia, and, less important, West Yorkshire. The West Country area comprised Gloucester, Wiltshire, Somerset, Dorset, Devon, and

[1] There was a third reason, the greater fluidity of rural industry. Writing of Lancashire textile industries during the sixteenth and seventeenth centuries, Wadsworth says 'organization was fluid and elastic . . . it was free to grow and expand on the lines best suited to its own special requirements' (A. P. Wadsworth and J. de L. Mann, *The Cotton Trade and Industrial Lancashire, 1600–1780* (1931), p. 53).

[2] Sam Hill of Soyland, in the West Riding, in the early eighteenth century could send 200 shalloons to London in one consignment and a fortnight later a further 200 (Heaton, op. cit., p. 298). The large capitalist clothier was, however, more common in the West Country and in East Anglia.

[3] Leland, *The Itinerary, 1535–43*, pt. 1, folios 27–8.

[4] J. Smith, *Memoirs of Wool*, vol. 1 (1747), p. 376.

[5] Nef, *Economic History Review*, vol. v, no. 1, p. 19.

[6] Nef, *Economic History Review*, vol. v, no. 1, pp. 6–7.

[7] These examples are employed by Nef to show that industrial capitalism was well established by the sixteenth and seventeenth centuries. The effects of price movements, of changes in the incidence of labour costs, and of the progress of technique are discussed by Nef in *Economic History Review*, vol. v, no 1, and in 'Prices and Industrial Capitalism, 1540–1640', *Economic History Review*, vol. VII, no. 2 (1937), pp. 155–85.

Cornwall (together with the adjoining parts of Worcester and Oxford); the East Anglian comprised Norfolk, Suffolk, and Essex; and the West Yorkshire included the adjacent parts of Lancashire and the North Riding. A wool textile manufacture was not, however, confined to these districts. Several towns in the south-east were still active in the sixteenth and seventeenth centuries, but had fallen into decay by the early eighteenth. Kendal greens were well known, as were Welsh frizes and 'cottons'. In the sixteenth century East Lancashire was a woollen area, but in the seventeenth century wool was retreating eastwards to the Yorkshire border and was being replaced by fustian. One area was, however, relatively devoid of a wool manufacture. This was the East Midlands, in reference to which Fuller makes the important comment: 'Observe we here, that mid-England—Northamptonshire, Lincolnshire, and Cambridge—having most of wool, have least of clothing therein.' The three main clothing districts, though their cloths overlapped to some extent, had each their own specialities of production. Within each district, too, there were separate local varieties.

In East Anglia the sub-regions were, firstly, North-east Norfolk; secondly, South Suffolk and North Essex. In North-east Norfolk the earliest centres were Worstead and Aylsham, and they lay in that part of the county most developed agriculturally as well as industrially.[1] Norwich, close at hand, became its later and most famous centre. Though broadcloths were also made, the main output of the region was worsteds. This was especially true after the introduction in the sixteenth century of the 'new draperies', relatively fine light cloths the technique of whose manufacture was introduced from the Low Countries. The second centre was South Suffolk and North Essex, including Hadleigh, Lavenham, Waldingfield, Melford, and Sudbury, in Suffolk;[2] Colchester, Dedham, Coggeshall, Maldon, Braintree, Bocking, and Witham, in Essex. Most of these had a stream-side situation. Ipswich and Bury St. Edmunds were doing little weaving in Defoe's time, though, as in the villages, there was much spinning.[3] The standard products in this second centre until the end of the sixteenth century were woollen broadcloths made from dyed wool, but the demand for them declined and their place was taken by the says, bays, and perpetuanas of the new draperies and by the combing and spinning of long wool for weaving in the Norfolk worsted industry and elsewhere.

The relationship of this East Anglian industry to the local physical and economic environment presents an interesting study. Sheep had long been an important element in the agricultural geography of

[1] P. M. Roxby, 'East Anglia', *Great Britain: Essays in Regional Geography*, ed. by A. G. Ogilvie (1928), p. 156.

[2] Unwin, *V.C.H. Suffolk* (1907), vol. II, pp. 255–6, 269.

[3] Defoe, op. cit., vol. I, pp. 45 and 52.

East Anglia and its ports had long been involved in the export of raw wool to the Low Countries. A wool textile industry was thus a natural result of local raw material and of space-relations alike. But the precise character of the industry was not determined by the local wool supply. The Norfolk Horn, the local breed in Norfolk, had short, relatively coarse wool; it had good felting properties but was suited only to the poorer quality broadcloths and was quite unsuited to the worsted manufacture. In the early nineteenth century it was mostly sent to Yorkshire and Lancashire for flannel-making.[1] The worsted industry of North-east Norfolk must have imported its long wools from Lincoln or the East Midlands, from the Lincoln or Leicester breeds. In Defoe's time Norwich received yarn from 'other Countries, even from as far as Yorkshire, and Westmorland'.[2] The Suffolk and Essex broadcloth manufacture could, however, have been based on local wool supplies. And these southern centres, with a stream-side situation, had some water-power (though the gradient was low and the streams in this dry eastern climate relatively uncertain and small in volume), which, since the application of the water-wheel to fulling in the fifteenth century, broadcloth manufacture required. It is not, however, certain to what extent the Suffolk cloths were fulled.

The West Country industry was widely flung, from the western scarps of the Wiltshire and Dorset chalk to the confines of Cornwall.[3] It had several local centres; first, the Stroud valley and the Cotswolds; second, the foot of the chalk scarp of the Wiltshire and Dorset Downs;[4] third, the Mendip country from Bristol and Bath to Wells and Frome; fourth, the Vale of Taunton and the margins of Dartmoor. Most of the Cotswold towns[5] were, or had been, woollen working centres, but in the seventeenth century the Stroud valley had become the most important and five hundreds in the neighbourhood had textile workers amounting to over one-third of all the names on a muster roll of 1608, a high proportion of the adult male population.[6] This was the district of superfine woollen broadcloths. Here the clothiers had a riverine distribution. By the early eighteenth century the second and third groups were making druggets, instead of single-coloured broadcloths as formerly. Defoe described these druggets as 'Fine Medley, or mix'd Cloths' and as 'fine Spanish Cloths'.[7] The mixture was not of combed and carded yarns, but of

[1] W. Youatt, *Sheep* (1837), p. 311.
[2] Defoe, op. cit., vol. 1, p. 61.
[3] Kinvig, op. cit., pp. 243–54 and 290–306; W. G. Hoskins, *Industry, Trade, and People in Exeter, 1688–1800* (1935), map, p. 29; G. D. Ramsay, *The Wiltshire Woollen Industry* (1943).
[4] Salisbury was an outlier of this group.
[5] For the significance of Witney see A. Plummer, ed., *The Witney Blanket Industry* (1934).
[6] A. J. and R. H. Tawney, 'An Occupational Census of the Seventeenth Century', *Economic History Review*, vol. v, no. 1 (1934), pp. 63–4.
[7] Defoe, op. cit., vol. 1, pp 280–2

woollen yarns dyed in different colours.[1] The designation 'Spanish Cloths' referred to the fine short wool imported from Spain, the fleece of the Spanish merino. The Vale of Taunton and the fringes of Dartmoor made serges which were mixed fabrics with a warp of combed long wool and a weft of short carded wool. Serges were fulled or milled, usually by water-power.[2]

The West Country had an abundance of local wool—in the Western Downlands, in the Cotswolds, along the Welsh Border, and in the South-west Peninsula. The West Country lay within the English Plain, the most developed part of medieval England, and it had Bristol, the second port of the kingdom. A woollen industry was appropriate and was early established. It was appropriate, too, that it should be the woollen and not the worsted industry, for there was water-power in abundance for fulling the finished broadcloth,[3] by reason of both relief and rainfall in this more highly accidented western part of the English scarplands. The West Country had also the best supplies of fuller's earth, worked in the neighbourhood of Bath, and of teazles, grown in the Vale of Gloucester[4] and in Somerset north of the Mendips. These were both required in finishing the finest broadcloths. Contemporaries laid great stress on the value of fuller's earth, export of which from the country was illegal. It was thus distinguished from East Anglia. To this extent the woollen industry of the West Country and the worsted industry of East Anglia were differentiated each in accordance with the different qualities of the local physical environment. Short carding wools, which the woollen industry required, came from the short-wool down breeds of the Western Downlands,[5] and, for the finer qualities of broadcloths, from the Welsh Border. Devon had both long and short wools.[6] The Cotswold breed kept in the neighbourhood of the finest broadcloth manufacture, however, was a long wool breed, and its fleece was accordingly unsuited to carding and fulling. But with the growth of the West Country manufacture the local wools became insufficient and wool was drawn in from a wider radius. The position was aggravated by the growth of arable at the expense of down pasture on the Western Downlands, which Defoe noted, for, although sheep were folded on the arable, the head of stock declined.[7] It was aggravated, too, by an increase in the coarseness of the wool consequential upon the better feeding associated with the New Husbandry. In the sixteenth and seventeenth centuries writers had been convinced of a correlation between poor heath pasture and fine wool,

[1] Youatt, op. cit., p. 222. [2] Hoskins, op. cit., p. 39.

[3] Leland observed 'tukkynge myles', i.e. fulling-mills, in a valley bottom near Frome (op. cit., pt. v, folio 73b).

[4] Kinvig, op. cit., pp. 247–8. [5] Defoe, op. cit., vol. 1, pp. 282–3.

[6] Heath breeds of Dartmoor and Exmoor were short-woolled as most heath sheep of the time, and the South Hams and Bampton (the present Devon Longwool) breeds, of South Devon and Middle Devon–Vale of Taunton respectively, long-woolled. [7] Defoe, op. cit., vol. 1, p. 283.

and there is reason to suppose that this was true, the fine short wool being the product of a deficient diet. Wool was drawn southwards into the West Country from Leicester, Northampton, and Lincoln, but these would be mainly long and not short wools. Some Irish wools and Kentish wools, probably both long[1] and short, were imported into Devon for the serge manufacture. But, in addition, merino short wools were imported from Spain, and these became increasingly important in maintaining the quality of the finest broadcloths.[2] Colonial wools, many of them from breeds derived from the merino, did not become available from the southern hemisphere until the early years of the nineteenth century.[3]

The third of the major wool-working regions was West Yorkshire. It comprised the upper valleys of the Calder and Aire and the lower hill country of these river basins as far east as the Vale of York. There was woollen working in other Pennine dales, but not on the same scale. The histories and guides of Leeds at the end of the eighteenth century all declared that not a single manufacturer was to be found more than one mile east or two miles north of the town.[4] Leeds and Wakefield, though important market centres of the industry, lay on the eastern margins of the industrial region. Leland mentions Wakefeld, Bradeforde, and Ledis as clothing towns, but he did not visit Halifax.[5] The famous Halifax Act of the reign of Philip and Mary bore witness to the importance of the industry in that district in 1555. To these Defoe added Huthersfield to make up 'the five Towns which carry on that vast Cloathing Trade'.[6] The production of West Yorkshire was of relatively coarse cloth, as was the rule in the North of England at this time. Leeds made broadcloths, but Halifax the narrow coarse kerseys, three or four of which were reckoned by the aulnager as equal to one broadcloth.[7] The Halifax Act of 1555[8] specified the small manufacturing unit (using one to four stones of wool per week) as the main element in the clothing industry of that district, and Heaton concludes that one kersey a week, requiring about two stones of wool and about five persons (one weaver, four carders and spinners), was the average

[1] During this period, before the Industrial Revolution, the export of wool was almost entirely of long wools. There was much clandestine export of wool in the late seventeenth and eighteenth centuries, and it was mainly of long wool. A pamphlet of 1694 asserted that two-thirds of the long wool grown on Romney Marsh was exported to France and the Low Countries (J. Smith, op. cit., vol. I (1747), p. 390); Romney Marsh was, of course, particularly well placed for this traffic. It is a striking commentary on this export of long wool that a worsted industry of any bulk was absent, as Fuller noted, from the East Midland counties, where most long wool was produced.

[2] Kinvig, op. cit., p. 246. [3] Youatt, op. cit., pp. 183–92.

[4] Heaton, op. cit., p. 284. [5] Leland, op. cit., pt. I, folio 46, and pt. IX, folio 53.

[6] Defoe, op. cit., vol. II, p. 594.

[7] Heaton, op. cit., p. 179, and J. Smith, op. cit., vol. I, p. 140.

[8] 'An Acte for Thinhabitantes of Halyfaxe touching the Byeng of Woolles (R. H. Tawney and E. Power, *Tudor Economic Documents*, vol. I (1924), pp. 187–8).

output of such small units in the fifteenth and sixteenth centuries. In many cases five workers could be provided by a single family, even young children being set to carding and spinning. But the family unit of manufacture may not have been typical of the whole area.[1] In the eighteenth century, towards the end of this domestic phase of the industry, considerable regional variations of production developed within West Yorkshire. Leeds became more and more a market centre, and with the reintroduction of worsteds at the close of the seventeenth century (first of the half-woollen and half-worsted bays and serges, later of the full-worsted shalloons) the western districts turned from kerseys to worsted cloths.[2]

The localization of the wool textile industry in West Yorkshire presents somewhat different problems to those presented by East Anglia and the West Country. West Yorkshire did not become an important manufacturing district until the latter part of the fifteenth century. In 1473–5 the combined output of the whole district, according to the aulnage accounts, only just exceeded the output of the single centre of York. East Anglia, the West Country, and the Vale of York lay within the English Plain, the focus of medieval life, in industry as well as agriculture. The West Yorkshire hills, a bleaker, less fruitful environment, lay outside it. Indeed, in the upper parts of the Calder Valley during the early part of the Middle Ages there had been several vaccaries, an extensive form of land utilization. The Halifax Act of 1555 claimed privileges on account of the benefit the small clothier was bestowing on the barren hillsides of the district, for he was reclaiming the land and keeping it in cultivation, which he could not do without his subsidiary income from the making of kerseys. The agricultural poverty of the district was evident. The increase of population in Halifax parish was there placed at 500 households within forty years. It seems improbable that these small-holders kept sheep in any number, or, indeed, that they kept sheep at all; the Act related to the buying of wool through a middleman, who himself brought it from some distance. In Lancashire, in Rossendale,[3] and in the Rochdale[4] district, however, small-holders kept sheep and practised industry side by side. In West Yorkshire the domestic industry retained a semi-rural character as well as a rural distribution until the time of the Industrial Revolution. The clothiers had each a few fields with a few head of stock, though the fields were employed for tenter-frames as well as farming, and of

[1] Prof. Cole doubts whether the family unit was typical even of the Halifax district *by the early eighteenth century*, and that may well have been true (G. D. H. Cole, Introduction to Defoe, op. cit., pp. xiv–xv).

[2] Heaton, op. cit., pp. 284–9. This succession is shown clearly in the *Letter Books of Joseph Holroyd and Sam Hill*, ed. by H. Heaton (1914). Holroyd's letters of 1706–7 specify kerseys and bays, but not shalloons; Hill's letters of 1738 specify kerseys, bays, and shalloons.

[3] Tupling, *The Economic History of Rossendale*, pp. 165–7.

[4] Wadsworth and Mann, op. cit., p. 27.

the stock some were used for carrying wool and pieces. The whole industrial population appears to have gone into the fields at harvest.[1] In West Yorkshire manufacture was for long only of the coarser cloths, and these, cheaply produced, could often be substituted for more expensive cloths made elsewhere. It is possible, indeed, that the West Yorkshire industry grew by reason of lower production costs on account of family labour and of the combination of industry with agriculture. Although it would not be wise to push the point too far, it is possible that the small master employing family labour was relatively more prominent in the *woollen* industry of West Yorkshire than elsewhere, and that, as a productive unit, he tended to carry on more processes under one roof than the clothiers in the more sectionalized industries of the West Country and East Anglia; that is, he tended more than they in the direction of a vertical organization.[2] This was truer of the earlier than of the later phases of the domestic system. The West Yorkshire *worsted* industry, however, was organized from the first by big clothiers who arranged their production sectionally.[3]

The West Riding industry was not favoured by its local wools: they were not plentiful and they were coarse. It was declared in 1588 that local wool was sent to Rochdale and that Halifax drew its raw wool from Lincolnshire.[4] A few decades later wool was being imported, because it was cheaper, from Ireland and Scotland. The implication of a pamphlet printed in the *State Papers* for 1615 is that from the Midland wool districts, some qualities were sent into West Yorkshire and quite other qualities into East Anglia, the one then a woollen and the other a worsted district.[5] In the eighteenth century West Yorkshire spun a good deal of yarn for weavers in East Anglia and the West Country, but especially for East Anglia. It seems clear that local wool supply had little to do with the precise character of the industry in any of the three major centres. The trade in raw wool was well developed and it was not expensive to transport relative to its weight. (This point is developed further in Chapter IX.) West Yorkshire was as well furnished with water-power as was the West Country, and was therefore suited to the woollen manufacture, its staple industry until the eighteenth century. The localization of worsteds during the eighteenth century in the upper Calder and Aire valleys was not due to lack of water-power,

[1] *Letter Books of Joseph Holroyd and Sam Hill.* A letter of 13 August 1706 observes: 'Now for six weeks will be little made' (p. 19).

[2] *S.P.D. James I*, vol. LXXX (1615). Quoted by Unwin, *Industrial Organization*, pp. 235–6, and by Heaton, *The Yorkshire Woollen and Worsted Industries*, pp. 293–4. See also Committee on Woollen Manufacture, 1806, *Report*, pp. 8–13. It is interesting to note that even at this early date the packing of cloth for export overseas seems to have been a specialized business.

[3] Heaton, *The Yorkshire Woollen and Worsted Industries*, pp. 296–8.

[4] Heaton, *The Yorkshire Woollen and Worsted Industries*, p. 118.

[5] *S.P.D. James I*, vol. LXXX (1615). Quoted by Unwin, *Industrial Organization*, p. 188.

as it may have been in East Anglia, for water-power was available here to as great an extent as anywhere else in the West Yorkshire textile district. The soft water of the Pennine streams was probably better in quality than the water of the West Country and certainly better than the water of East Anglia. Defoe's description of the Halifax district shows how intensively this water was employed; a flow of water being available for every house.[1] For the dispersed hillside settlements that is still largely true to-day.

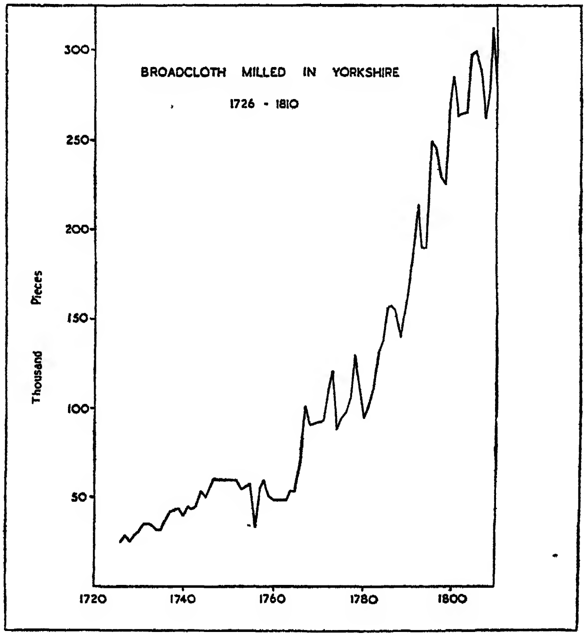


Fig. 10

BROADCLOTH MILLED IN YORKSHIRE, 1726–1810

Eastern Lancashire, adjacent to West Yorkshire and with a very similar physical environment, was also a woollen area. When West Yorkshire was weaving kerseys and broadcloths, east Lancashire was making 'cottons' and frizes, relatively light and coarse woollen goods.[2] Lancashire adopted the half-worsted bays early in the seventeenth[3] century and the full-worsted shalloons by the eighteenth. In almost every respect, the woollen area of eastern Lancashire was similar to West Yorkshire—in physical environment, in the presence of water-power, in a farmer-weaver economy,[4] and, though the precise

[1] Defoe, op. cit., vol. II, pp. 601–2. [2] Wadsworth and Mann, op. cit., p. 12.
[3] Wadsworth and Mann, op. cit., p. 13.
[4] Wadsworth and Mann, op. cit., pp. 25–8, and Tupling, op. cit., pp. 161–91.

character of the fabrics differed, in a generally coarse class of woollen manufacture. But it was only the Pennine slopes which were involved in wool. There was little woollen-working in the West Lancashire Plain or, indeed, in Manchester. Though woollen cloths were merchanted in Manchester, the place itself was concerned more with linen and with cotton smallwares. Between the woollen of upland eastern Lancashire and the linen of the West Lancashire Plain, there arose during the course of the seventeenth century an intermediate belt[1] running through Blackburn, Bolton, and what is now Oldham (but excluding Bury and Rochdale), whose staple fabric was fustian, made of a linen warp and a cotton weft. The employment of these materials provides an interesting illustration of the impossibility of ascribing the precise character of a textile industry to its local textile raw materials. Once a textile industry is established, based initially perhaps on local raw materials, it changes its character comparatively easily with changes in demand for particular fabrics. Linen-weaving in West Lancashire and Manchester, originally based on local flax, had outgrown local supplies by Leland's time, when Liverpool was importing 'moch Yrisch yarn'.[2] In the eighteenth century linen yarn was being imported also from the Continent, the shores of the North Sea and Baltic. Cotton, of course, was entirely imported: it came through London from the Levant. The weaving of fustians in Britain seems to have come in with the new draperies in the second half of the sixteenth century.[3] Its adoption in Lancashire coincided with the adoption of other new fabrics, such as bays, and marked, as A. P. Wadsworth puts it, a minor industrial revolution. It was not the only mixed cotton-linen fabric: checks,[4] which had a similar character, were made for tropical markets.[5] When fully developed, the Lancashire fustian industry depended entirely on imported materials and the check industry largely on foreign markets as well. They were the forerunners in this respect of nineteenth-century industrialism. As the eighteenth century wore on more cotton and less linen was put into these mixed fabrics and there were attempts at making muslins from hand-spun cotton yarn. They were not very successful and the emergence of a pure cotton manufacture on any substantial scale, for reasons which the late Prof. Daniels explained, had to await the invention of the mule.[6]

[1] This represented in large measure a retreat of the woollen belt eastwards. Leland (op. cit., pt. IX, folio 57) had described Bolton as depending mostly on 'cottons and cowrse yarne'.

[2] Leland, op. cit., pt. IX, folio 56. This may have been woollen yarn equally as linen yarn. C. Gill, *The Rise of the Irish Linen Industry* (1925), assumes it to have been linen yarn, p. 6.

[3] Wadsworth and Mann, op. cit., p. 19.

[4] Checks and fustians were not identical. See Wadsworth and Mann, op. cit., Preface, pp. vi–vii.

[5] Wadsworth and Mann, op. cit., p. 173.

[6] G. W. Daniels, *The Early English Cotton Industry* (1920).

The woollen industry in Wales, as at first in the North of England, had a relatively coarse character. 'Cottons', frizes, and flannels were its staple cloths. The wool of upland Wales was coarse in character, though that of the English parts of the Welsh Border was the finest in the country. The industry was a part-time farmer's occupation and it fitted well into the pastoral character of much Welsh farming.[1] There was an abundance of water-power and, it will be noted, its fabrics were mainly woollens. In Scotland woollen and linen cloth had long been made from locally-grown wool and flax, the former largely in the form of rough plaiding for home ware, but the burghs made cloth of better quality. The Scottish woollen industry never developed to the same degree as the English and wool continued to be exported from Scotland to the Continent and, as the Yorkshire industry grew, to the West Riding. The Tweed Valley woollen industry did not develop on any considerable scale until the end of the eighteenth century.[2]

Even in the Middle Ages there had been a divorce in the iron industry between the initial reducing or smelting processes, located where ore was mined and charcoal made, and the crafts working up the malleable iron into finished consumption goods, located in the towns. The divorce was never complete, for some articles—those, no doubt, requiring less skill in fashioning—were made in forges attached to the bloomery hearths or smelting furnaces. In the period prior to the Industrial Revolution there was again a distinction in geographical distribution between smelting and finishing, though it was of a different nature.

Smelting was localized, as it had been previously, where there was access to both ore and charcoal.[3] Most of the ore bodies and ore deposits were known, but they were not all worked with equal intensity. Not only had ore to be available but also charcoal and, where both were not available on the same sites, ore was carried to charcoal and charcoal to ore. According to Scrivenor, writing in the middle of the nineteenth century, one ton of pig iron required two loads of charcoal or four loads of wood.[4] Mushet, in 1840,

[1] Much of the production, of course, was used for clothing at home, but there was an export of Welsh cloths from Bristol, at any rate as early as the first half of the fourteenth century (E. M. Carus-Wilson, *The Overseas Trade of Bristol in the later Middle Ages* (Bristol Record Society) (1937), p. 185 and elsewhere).

[2] Defoe noticed the export of wool from Tweeddale and the absence of a woollen manufacture.

[3] The evidence of the Spencer papers referring to South Yorkshire is very valuable. Furnaces were invariably close to the ironstone and on water-power sites. Charcoal was made within a radius of 10–15 miles of the furnaces and it was made from coppice wood of oak and ash of 15 years' growth, and even from hedge timber. Forges were heated with small charcoal and had hammers worked by a water wheel (A. Raistrick and E. Allen, 'The South Yorkshire Ironmasters', *Economic History Review*, vol. IX, no. 2 (1939)).

[4] H. Scrivenor, *History of the Iron Trade* (1854), p. 55. Presentments of juries in Sussex in 1548–9 printed by Tawney and Power (op. cit., vol. I, pp. 233 and 236) specify three loads of wood to one load of charcoal.

calculated that a charcoal blast furnace with an annual production of 1,000 tons of iron required 120 acres of woodland to be cleared of timber annually in order to keep it in full operation.[1] The availability of water-power was a second factor, for the water-wheel was used for the blast and the hammers. By the time of Elizabeth timber was becoming scarce, but the technique of iron smelting remained dependent on charcoal. There ensued a centrifugal scatter of iron smelting, as Prof. Ashton has described.[2] A Wealden ironmaster migrated to the South Wales coalfield and another ironmaster from Robin Hood's Bay to the interior of Durham. The Backbarrow Company of Furness set up a furnace at Invergarry, the Newlands Company one in Argyll, and the Duddon Company one near Inverary. In the case of these Scottish furnaces ore had to be transported from Furness or West Cumberland and the smelted iron returned for further reworking. These examples of long-distance transport refer to the coastwise trade: there was also a brisk trade in iron along the Severn: but land carriage was over shorter distances except for pig iron and bar iron. The distribution of furnaces and forges for 1717 are shown in Fig. 11 and in Table VII. The source is the MSS. of John Fuller and Son, Gunfounders, Heathfield, Sussex. It is not a census in the modern sense and may contain omissions or errors due to incomplete knowledge. Furnaces were most numerous in the Weald,[3] in the West Midlands and the lower Severn Valley (including the Forest of Dean and the eastern end of the South Wales coalfield), and in Yorkshire and Derbyshire, but the largest furnaces were in the West Midlands and the lower Severn Valley, over half of the total production of pig iron coming from these two districts.

Although there were many forges in the charcoal-iron smelting districts, these did not monopolize the manufacture of finished iron goods. The refining and forging of pig iron required more charcoal than did smelting, about half as much again according to Scrivenor. A list of Wealden ironmasters in 1573[4] shows that approximately two-thirds of the furnaces and forges were combined in single ownership, probably, though not necessarily, on the same site. But this was in the sixteenth century, and in the Weald, which retained longest the older characteristics. Its forges, like its furnaces, were

[1] Charcoal was made not so much from forest timber (from branches and small logs rather than building timber), but chiefly from coppices, specially planted for the purpose.

[2] T. S. Ashton, *Iron and Steel in the Industrial Revolution* (1924), pp. 13–23.

[3] Furnaces in the Weald were at this time wholly valley bottom sites whose blast was provided by water-power from impounded waters. The sites were chiefly in the High Weald for reasons of power, as well as of source of ore and of charcoal. See maps in G. S. Sweeting, *Proc. Geol. Assoc.* (1944), Figs 1 and 3, and in M. C. Delany, *The Historical Geography of the Wealden Iron Industry* (1921), maps 2 and 3.

[4] Ashton, *Iron and Steel*, p. 6.

TABLE VII

Iron Furnaces and Forges in the Early Eighteenth Century

	Furnaces			Forges		
	No.	Total output tons	Average output per furnace in tons	No.	Total output tons	Average output per forge in tons
South-east	11	1,990	181	15	926	62
South Wales and Forest of Dean	14	5,250	375	29	2,700	93
North Wales and Cheshire	5	2,250	450	8	840	105
West Midlands	14	5,400	386	46	6,820	148
North-west	2	1,000	500	—	200	—
Yorks, Derby, Notts	9	2,300	256	16	1,690	106
North-east	—	—	—	1	120	120
Total	55	18,190	331	115	13,296	114

From E W. Hulme, 'Statistical History of the Iron Trade of England and Wales, 1717–1750'. *Trans. Newcomen Society*, vol. IX (1928–9). List A, pp. 21–2. The date is 1717. For a discussion of the West Midlands based on manuscript accounts see B. L. C. Johnson, *Birmingham and its Regional Setting* (1950), pp. 168–73, and the same author's 'The Charcoal Iron Industry in the Early Eighteenth Century' in the *Geographical Journal*, vol. CXVII, part 2 (1951), pp. 167–77.

IRON FURNACES AND IRON FORGES IN 1717

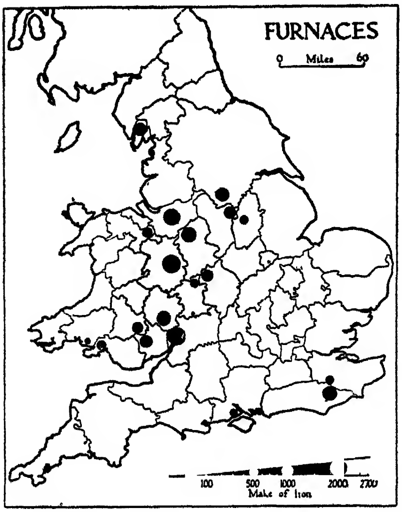


Fig. 11A

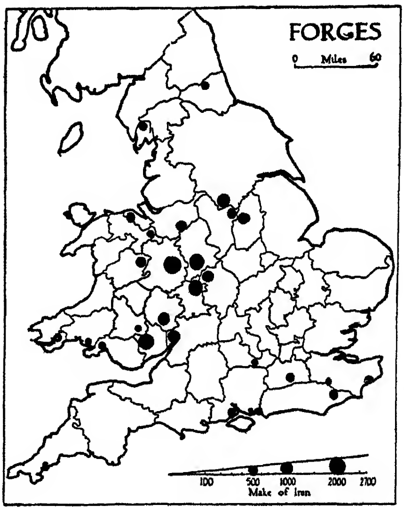


Fig. 11B

A represents Furnaces and B Forges and the symbols are in proportion to 'what Iron they are supposed to make or can make one year with another', according to the phrasing of the MSS The scale is identical in the two maps.

the smallest in average size of any district. The greatest number of forges in the early eighteenth century was not in the Weald but in the West Midlands. These West Midland forges used much more iron than the local West Midland furnaces produced: the West Midlands region was an importer of pig iron, unlike the South-east and North and South Wales, which were exporters of pig iron. In 1737 it was calculated that within 10 miles of Birmingham 9,000 tons of bar iron were used annually, the greater part being by nail-makers working under the domestic system.[1] The total annual production of bar iron in England and Wales at this time was probably under 20,000 tons, but at least as much was imported. There were other groups of forges and smithies near Sheffield[2] and in the north-east. It will be noticed that these areas where finished iron was mainly made were coalfield sites. The import of bar iron gave rise to smithies at Newcastle, Hull, and London (importing iron from Sweden and Russia), and at Bristol and Liverpool (importing iron from America). Sweden, Russia, and North America all had timber, and therefore charcoal, in immense quantities.

During the Middle Ages coal was worked in most British coalfields, but, except in North-east England, it was on an infinitesimal scale and for strictly local use. Timber and peat were yet plentiful. But from the middle of the sixteenth century output began to increase. According to the generalized estimates made by Prof. Nef, the total production in Great Britain was 0·21 million tons in 1551–60, 2·98 in 1681–90, and 10·30 in 1781–90;[3] and, according to estimates quoted by Prof. Ashton and Prof. Sykes, it was 2¼ million tons in 1660, 2½ in 1700, over 6 in 1770, and over 10 in 1800.[4] The increase was due to a growing shortage of timber, making imperative the use of an alternative fuel, and the growing shortage of timber was due to the increase of population with its demand for firewood; it was due to the increase in the navy and merchant shipping with their demand for oak; and it was due to the growth in industries consuming timber. Prof. Nef quotes Wiebe to the effect that the rise in the price of firewood greatly outstripped the rise in general commodity prices: in 1633–42 general prices were nearly three times as great as in 1451–1500, but firewood prices were nearly eight times as great.[5] Presentments of a Sussex jury in 1548–9 afford an interesting local example: 'within 15 years last past upon the downs a load of wood was commonly bought and sold for 14*d*., and now by occasion of

[1] Ashton, *Iron and Steel*, p. 19.

[2] In Hallamshire Defoe reported, though he would pronounce no opinion on the veracity of the figure, 30,000 men employed in cutlery and hardware (op. cit., vol. II, p. 590).

[3] Nef, *The Rise of the British Coal Industry*, vol. I, p. 20.

[4] T. S. Ashton and J. Sykes, *The Coal Industry of the Eighteenth Century* (1929), p. 13.

[5] Nef, *The Rise of the British Coal Industry*, vol. I, p. 158.

the mills and furnaces every load is enhanced to *2s. 8d.* and *3s.*. And in the Weald among the woods a load of wood was commonly bought and sold for *4d.*, and now by occasion of the mills every load is enhanced to the sum of *12d.*'[1] The higher price on the downs than in the woods is noticeable. Although the firewood shortage was most acute in the towns and particularly in London, it was present also in most country districts. Enclosure with its hedgerow timber alleviated the position to only a very small extent. The price of coal rose much less than the price of firewood and coal was used increasingly for domestic firing. Tudor houses with their stacks of chimneys adapted for coal-burning revolutionized domestic architecture. This was an age of maritime expansion and of naval wars, and sound oak was required in quantity by the shipyards.[2] The inroads of the iron industry were very considerable and, although iron smelting may not have continued to grow in the seventeenth century, it is improbable that replanting of woodland kept pace with charcoal burning. The finishing of iron goods was becoming concentrated more and more on the coalfields, where an alternative fuel was available. Fuel was needed in increasing quantities for salt-making,[3] both inland and coastal, for glass-making, for soap-making, for alum, for copperas, and for bricks. Many of these growing industries turned over to coal. For the country as a whole, Nef estimates that in this period approximately one-third of the total output of coal was consumed for industrial and two-thirds for household purposes.

But, although the employment of coal was thus increasing steadily, there were many districts of the country where coal was not used. Nef estimates that the average distance of land carriage from pithead to point of consumption was no more than 15 miles and that the 'price of coal seems almost to have doubled with every two miles it was carried from the mines'.[4] The carriage of coal was normally only a six-months summer business, and even the coastwise colliers were laid up during the winter months.[5] Nef has drawn up a generalized map of the areas of coal production and consumption in the late seventeenth century. The English Plain, devoid of local supplies, consumed coal only around the coasts and along those east coast rivers which were navigable—the Ouse and Trent, the rivers of the Wash, the Thames, and, for shorter distances, the East Anglian rivers. York drew some of its coal by coastwise and river traffic from the North-east coalfield, involving a 200-mile journey, as well as

[1] Tawney and Power, op. cit., vol. I, p. 236.

[2] 'Between 1550 and 1660 the total tonnage of the Royal Navy apparently increased sixfold' (Nef, *The Rise of the British Coal Industry*, vol. I, p. 173).

[3] P. Pilbin, 'A Geographical Analysis of the Sea Salt Industry of North-east England', *Scottish Geographical Magazine*, vol. LI (1935), pp. 22–8. The Teesmouth industry, with no local coal, declined in favour of those actually on the coalfield.

[4] Nef, *The Rise of the British Coal Industry*, vol I, pp. 102–3.

[5] Defoe, op. cit., vol. I, p. 41.

from the Yorkshire coalfield, some 20 miles away.[1] The industrial parts of East Anglia are marked as coal-consuming districts, and Defoe records that many of the colliers engaged on the Newcastle–London trade were owned by Yarmouth sailing-masters who within his own recollection had largely replaced the Ipswich men.[2] The greater part of the West Country industrial district (except the Cotswold valleys) is similarly marked as receiving coal from Bristol, the Forest of Dean, and South Wales. East Anglia and the West Country, therefore, had access to coal. But there was a wide belt of agricultural land in southern England, where coal was used only by the more wealthy of the rural population, and where the labourer was reduced in the eighteenth century to burning dried dung.[3] Many of the hill districts of upland Wales and of the Northern Pennines, of the Southern Uplands and of the Highlands of Scotland were also too far removed from the coalfields to permit coal to be carried to them except at a prohibitive cost. It was only where water transport was available that coal was widely distributed and the realization of this was the urge to many, if not most, of the canal projects of the late eighteenth and early nineteenth centuries.

The most extensively worked coalfield was that of Northumberland and Durham. It had been the most important in the Middle Ages, and it remained the most important until well on in the nineteenth century. Its early development was due to the cropping out of seams along the coast and along the River Tyne which permitted, by reason of access to the coastal trade, a wide diffusion of its products—'from whence not London only, but all the South Part of England is continually supplied'.[4] No other coalfield lay so close to the east coast or had such facilities for supplying by sea that part of the country devoid of coal. As mining proceeded larger and larger areas of the exposed field were involved. On Tyneside the early workings were all of surface outcrops close to the river, but the later workings lay some distance back from the river-front—some 8–10 miles by 1700.[5] Mining at such a distance away from the river led ultimately to the erection of wagon-ways which replaced packhorses. This method of transport may not have been first used in the north-east, but it was adopted here extensively.[6] The coal mined was chiefly that suitable for household use. The pan-coal used by the salt industry was the slack inevitably produced in working for lump coal. The steam-coal district of Northumberland, despite its coastal situation, was not worked on a considerable scale until the end of the seventeenth century. Nef estimates the production of the whole coalfield at the end of the eighteenth century in round figures at

[1] Nef, *The Rise of the British Coal Industry*, vol. I, p. 102.
[2] Defoe, op. cit., vol. I, pp. 40–1, 67–8.
[3] Clapham, *Early Railway Age*, p. 78. [4] Defoe, op. cit., vol. II, p. 659.
[5] Nef, *The Rise of the British Coal Industry*, vol. I, p. 28.
[6] The first reference that Ashton and Sykes give is near Nottingham in 1610 (Ashton and Sykes, op. cit., p. 63).

1·2 million tons, of which 0·8 million tons was exported coastwise and abroad, the greater part (0·7 million tons) to London and the east and south-east coasts. Tyneside and Wearside had a monopoly of the London market until the early nineteenth century, and the old Tyneside pitman with relatively high wages was an aristocrat among the artisans of his day.[1]

III

THE INDUSTRIAL REVOLUTION

The late eighteenth and early nineteenth centuries constituted a period of active technical improvement of industry as well as of agriculture. The Agrarian Revolution was paralleled by the Industrial Revolution.[2] Both involved a more efficient use of material, the former of soil and climate, the latter of raw materials and power. Both involved particularly a much more efficient use of labour. Both resulted in marked changes in geographical distribution, and in an accentuated regional specialization of production. Individual districts devoted themselves wholly to one form of enterprise and particular industries (but not yet particular forms of agricultural production to the same extent) tended to become concentrated in a single or in a relatively restricted number of localities.

What were the characteristics of the new industrial economy? Its first characteristic was that it was a machine industry as distinct from a handicraft industry. It was not that machinery was new to industry: the hand-loom was a machine equally with the power-loom. But the new machines, when set in motion, themselves performed the industrial process and the operative became a minder of machines making the fabric instead of the creator of the fabric himself. This implied, what Ruskin deplored, that the workman ceased to be a craftsman, but it also implied a much greater uniformity of product, and it enabled a manufacturer to supply an article more exactly according to specification. The mechanization of industry, however, proceeded irregularly and at an uneven pace. It came much earlier in the cotton, for example, than in the woollen, and in the cotton and worsted industries it came earlier in spinning than in weaving.[3]

[1] E. Welbourne, *The Miners' Unions of Northumberland and Durham* (1923).

[2] The term 'Industrial Revolution' is, of course, only a label of convenience. It includes a complex of changes—technical, economic, social, and political—and when described as referring to the period 1750–1850 it is limited arbitrarily to a time when change was most rapid. The period prior to 1850 represents, in fact, the first phase of the Industrial Revolution, and the second phase, after 1850, presented rather different qualities.

[3] For example, in 1833, out of 74 worsted factories in Yorkshire, 66 were for spinning only, 7 both spun and wove, and only 1 was for weaving only. (Calculated from the returns of the Children's Employment Commission (1834) by H. D. Fong, *Triumph of Factory System in England* (1930), p. 86.) The saving from machine-spinning was self-evident, but the saving from power-loom weaving was for a time problematical, for the cost of operating the machines and keeping them in repair had to be set against the saving of labour at the loom (J. Bischoff, *A Comprehensive History of the Woollen and Worsted Manufactures*, vol. II (1842), p. 273).

Some industries, or at least some processes within those industries, remain in a handicraft phase even to-day. Industries manufacturing a standard product on a large scale are obviously more suited to mechanization than industries making individualized articles for a restricted market. Clearly, at any one moment during the course of the Industrial Revolution, the pattern of industry was a mosaic of old and new, of handicraft and of machine manufacture. The substitution of factory for handicraft manufacture implied that materials contributed an increased and labour a decreased share of total costs of manufacture, and, as a corollary, that industry became more closely located by its materials than hitherto.[1]

The second characteristic of the new industrial economy was that its machines were driven by power. Some early models may have been worked by hand or by animal labour, but most machines were too heavy to be so driven. Machines driven by power were employed long before the Industrial Revolution, wind and falling water being harnessed even during the Middle Ages, but only on a very restricted scale. From the fifteenth century onwards water-power was used more extensively. Wind and water-power are intermittent and unreliable, and in Great Britain, with its variable winds and its small streams and rivers, were adequate for only small industrial units. A single mountain stream could provide a sufficient gradient for many water-wheels in turn, but each water-wheel was large enough to drive only a limited number of machines. Before the Industrial Revolution and during its early phases water-power drove cutlery grindstones, forge hammers, mine pumps, spinning-frames, fulling-mills, and corn-mills. The use of water-power meant geographically a dispersed and rural industrial distribution. But the intermittency of working and the distribution in small units were both unsatisfactory. It was the lack of water during 'the thirsty season' that first interested Matthew Boulton in a steam-engine. The steam-engine erected at the Soho Manufactory in Birmingham was engaged in pumping water to drive the water-wheel, which in turn drove the machines for polishing and turning the buttons and inlaid goods, metal wares in whose manufacture Boulton was engaged.[2] The same volume of water could thus be used time and time again and a constantly renewed supply was unnecessary. The Boulton and Watt engine was a great improvement on the Newcomen, which had preceded it, in respect of fuel efficiency, and the annual payment due to

[1] W. Smith, 'Mobility in the Location of Industry in Great Britain', *The Advancement of Science*, vol. VI, no. 22 (1949), pp. 115-17.

[2] J. Lord, *Capital and Steam Power* (1923), pp. 95-7 and 153. Ashton states that it was as a substitute for horse-power that attracted Boulton to the steam-engine (Ashton, *Iron and Steel*, p. 62). The water-wheel interpretation is adopted also by D. Brownlie, 'Steam Power in Evolution', *Journal Textile Institute* (1927). The earliest Watt engines had a horse-power of 15-20, about the horse-power of the larger water-wheels. But they soon increased and, being thus able to drive more and more machines, permitted larger factory premises.

Boulton and Watt was at first calculated on the difference in coal consumption between the two.[1] This greater fuel efficiency was of considerable significance, for it permitted the Boulton and Watt engine to be used in industries other than coal-mining. Over half the Newcomen engines in 1769, but little more than one-tenth of the Boulton and Watt engines erected between 1775 and 1800, were installed at collieries. There were only six Boulton and Watt engines at collieries on the Northumberland-Durham coalfield between 1775 and 1800: the same field had had fifty-seven Newcomen engines in 1769. The saving of coal was of little advantage to colliery owners. Just over one-quarter of the Boulton and Watt engines, but 85 per cent of the Newcomen engines, were devoted to pumping water—in coal and ore-mines, or for canals and waterworks. Between 1775 and 1800 the Boulton and Watt partnership had a monopoly of steam-engine manufacture on the Watt principle and, as full records of the firm's trading have been preserved, it is possible to draw up

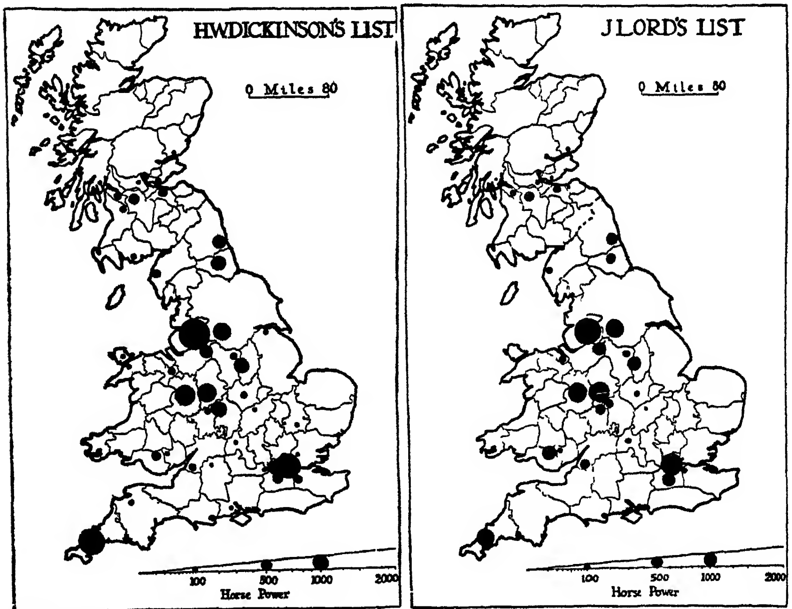


Fig. 12A Fig. 12B

BOULTON AND WATT STEAM-ENGINES, 1775–1800

The size of the symbols varies in proportion to the total horse-power of the engines erected in each county during the period. Map 12A has been re-drawn from the Science Museum map reproduced in H. W. Dickinson's *Matthew Boulton* (p. 177), a map which distinguishes separately reciprocating and rotative engines. Map 12B has been drawn from the lists in J. Lord's *Capital and Steam Power*. The maps are not indentical in precise quantities.

[1] Lord, op. cit., p. 109. According to one of Watt's letters, the efficiency per bushel of coal was almost four times as great. The Newcomen was the first successful 'fire-engine'. For the history of the steam-engine see H. W. Dickinson, *A Short History of the Steam Engine* (1939).

TABLE VIII

Distribution of Boulton and Watt Steam-engines, 1775–1800 (A)

	Textiles	Collieries	Ore-mines	Iron Works	Pottery and Glass	Canals	Water Works	Corn Mills, Breweries, Distilleries	Others	Total
Cheshire	9	—	—	—	—	—	—	1	2	12
Cornwall	—	—	21	—	—	—	—	—	—	21
Cumberland	—	3	—	—	—	—	—	—	—	3
Derby	1	1	1	—	—	—	—	1	—	4
Durham	4	—	—	—	—	—	—	—	2	6
Essex	—	—	—	—	—	—	1	—	1	2
Gloucester	1	—	—	—	—	3	—	1	1	6
Kent	—	—	—	—	—	—	—	3	—	3
Lancashire	47	—	—	—	2	3	—	1	2	55
Leicester	2	—	—	—	—	—	—	—	1	3
Lincoln	—	—	—	—	—	—	—	—	1	1
Middlesex	5	—	—	—	—	1	10	15	10	41
Northampton	1	—	—	—	—	—	—	—	—	1
Northumberland	1	6	—	—	—	—	—	—	2	9
Nottingham	15	—	—	—	—	—	—	1	1	17
Oxford	—	—	—	—	—	1	—	2	—	3
Salop	1	13	—	11	—	—	—	—	—	25
Stafford	1	4	—	11	4	9	—	—	2	31
Surrey	3	—	—	3	—	—	1	4	5	16
Warwick	1	3	—	1	—	—	—	1	—	6
Wiltshire	—	—	—	—	—	1	—	—	—	1
Worcester	—	—	—	1	—	—	—	—	—	1
Yorkshire	12	—	—	4	—	—	1	2	3	22
Anglesey	—	—	1	—	—	—	—	—	—	1
Flint	—	—	—	1	—	—	—	—	—	1
Glamorgan	—	2	—	3	—	—	—	—	—	5
Monmouth	—	—	—	1	—	—	—	—	—	1
Argyll	—	—	—	—	—	1	—	—	—	1
Clackmannan	—	—	—	—	—	—	—	2	—	2
Edinburgh	—	1	—	—	1	—	—	1	—	3
Falkirk	—	—	—	—	—	—	—	1	—	1
Fife	1	—	—	—	—	—	—	—	—	1
Forfar	1	—	—	—	—	—	—	—	—	1
Haddington	—	—	—	—	—	—	—	1	—	1
Lanark	3	—	—	1	—	—	—	2	—	6
Perth	1	—	—	—	—	—	—	—	—	1
Renfrew	4	—	—	—	—	—	—	—	—	4
Total	114	33	23	37	7	19	13	39	33	318

From J. Lord, *Capital and Steam Power* (1923).

a table of the geographical distribution of Boulton and Watt steam-engines in the last quarter of the eighteenth century, and of the industries for which they provided power. These particulars, summarized from Lord's tables, are set out in Tables VIII and IX and in map form in Fig. 12.

Most of the industries of the country had steam-engines to a greater or less extent. Cotton-mills, woollen- and worsted-mills, flax-mills, textile finishing works, forges and foundries, metal workshops;

South Wales, and London. Pumps worked by steam were widely distributed when used for canals, but practically confined to London when used for waterworks. Corn-mills, breweries, and distilleries worked by steam were widely diffused, mainly in non-industrial districts, but the largest single group was in London and the Home Counties. It will be clear from this bare catalogue that 'steam-industrialism' was most highly developed in Lancashire, Cheshire, and Yorkshire, in the West Midlands, and in London; and to a lesser degree in Nottingham, the North-east coalfield, South Wales, Cornwall, and the West of Scotland. It is not without significance that with the exception of London and Cornwall, these were all coalfields. London and Cornwall, indeed, were special cases. Though the steam-engines associated with transport and public services and with food and some miscellaneous industries were remote from the coalfields, those attached to textile mills, forges and foundries, pot-banks and glassworks were with few exceptions directly on the coalfields. 'Every traveller in Britain,' remarked Prof. J. H. Clapham, 'noticed the extraordinary way in which industry and population were being concentrated on or near the coal measures.'[1] The new industrial economy, based on steam-driven machines, was bound up essentially with the coalfields.[2]

The third characteristic of the new industrial economy, consequential in fact on those just considered, was that it consisted of relatively large operating units. Machines and steam-engines both required capital, and for it to be run economically a steam-engine needed to operate not one but many machines. A water-wheel or a steam-engine harnessed to drive a single loom could be a wasteful and expensive use of resources and equipment. The factory became the typical industrial unit and the large capitalist or the joint-stock company the typical business unit. Neither originated with the Industrial Revolution. Though rare in the textile industries, there had been 'factories' in the sense of large groups of workers collected together on one site, in the sixteenth century. There had long been large capitalists, though in the textile industries they tended to employ their capital in stocks of materials rather than in buildings and machines. There had long been joint-stock companies, but they tended to be in banking and public works rather than in manufacture. In the early eighteenth century, even in the textile industries organized mainly on the domestic or putting-out system, 'factories' were becoming more numerous, and they became still more numerous

[1] Clapham, *Early Railway Age*, p. 42.

[2] Steam-engines increased steadily and before 1838 steam-power had outpaced water-power in textile factories. The following table has been constructed from Fong's abstracts of Factory Inspectors' Returns for 1838:

	Cotton h.p.	Woollen h.p.	Worsted h.p.	Silk h.p.	Flax h.p.
Steam-power .	40,589	10,847	5,863	2,309	3,134
Water-power .	9,478	6,844	1,313	928	1,131

after the middle of the century. Even before the adoption of water-power or steam-power hand-looms were gathered in groups up to 100 in loom-shops under one roof. Gott's Bean Ing Mill in Leeds employed 744 persons wholly on the premises in 1813, all except some 200 scribblers, etc., still on hand-operated processes. With the installation of power to drive the machines, the factory tended to get larger. As early as 1815–16 there were two spinning-mills in Manchester, each of which had an average employment of over 1,000.[1] But the growth in the size of the manufacturing unit was irregular and spasmodic and small establishments existed side by side with the large. It depended not only on the progress of technique, but also on the nature of the industry. There is a wide variety in the size of the firm and of the factory in the cotton industry, for example, even to-day and the variety is certain to persist. In the Birmingham metal trades, to give another modern example, the number of workshops is legion. The large industrial unit led to a growth in the size of the settlement unit. The farmer and the manufacturer were ceasing to be one person before the Industrial Revolution and, with the establishment of power-driven factories, the factory-worker became a full-time operative. The rural character of industry became less and less pronounced and the urban character more and more pronounced. It is not that there was migration of industry from the country to the towns, but that as factories grew settlements grew with them. Former villages became towns and towns grew into cities, and some of these acquired legal urban status.

There is not space, of course, to deal with the geographical consequences of this first phase of the Industrial Revolution over the full and complete range of British industry. A sample only will be given, for the cotton, the woollen and worsted, and the iron and steel industries.

The antecedents, both in mechanical devices and in economic organization, of the Industrial Revolution in the textile industries date back to the seventeenth century. For an account of these the reader is referred to *The Cotton Trade and Industrial Lancashire*, by A. P. Wadsworth and Miss J. de L. Mann. We are concerned here only with their geographical consequences. Hargreaves, Arkwright, and Crompton, the inventors of spinning frames, were all Lancashire men. Hargreaves's spinning jenny (the first) varied greatly in size; smaller models with twenty-four spindles or less did not require power and were widely adopted by cottage spinners organized on the domestic system. Before he had invented his mule, Samuel Crompton had used a jenny of eight spindles. Larger models were collected into factories and some were driven by power. They were often made by mechanics on the spot where they were to be used, and there was little standardization. Arkwright's famous mill at Cromford on the Derwent was started in 1771 and was driven by

[1] Clapham, *Early Railway Age*, p. 184.

water-power; his machine came to be known as the water-frame in contrast to Hargreaves's jenny, the smaller models of which were worked by hand. By 1780 there were in operation some fifteen to twenty factories employing Arkwright's water-frames, comprising 30,000 spindles in all and distributed in Lancashire, Derbyshire, Yorkshire, Nottingham, Cheshire, and Denbigh. They were invariably in factories. The water-power factories, whether using the jenny or the water-frame,[1] spun chiefly cotton twist or warp, weft being spun by hand, either on the wheel or on a small jenny in the cottages on the domestic system. In 1780 (he had begun to work on it in 1774) Crompton's mule was made public.[2] The mule spun much finer cotton yarns than either the jenny or the water-frame.[3] If Arkwright had made calicoes possible, Crompton made possible the much finer muslins. The mule was first known, in fact, as the muslin wheel.[4] At first, the mule, like the jenny, was a hand-machine, but water-power and the steam-engine were soon in turn applied to it. These machines were set up not only in Lancashire, Cheshire, and the Southern Pennines generally, but also in the West of Scotland, which had been making attempts at muslin manufacture since 1780. The spate of spinning-mill building along the streams and rivers of the West of Scotland was between 1785 and 1795.[5]

There was thus a phase in the development of cotton-spinning when hand-spinning and water-power spinning existed side by side. Hand-spinning was still organized on the domestic system, though jennies and mules, especially when driven by power, were being collected into factories; and cotton-spinning in its total sense had a widely dispersed geographical distribution. Water-power spinning, necessarily in factories, had a linear distribution along the rivers, whether in the towns[6] or in the country. But the water-power sites in the towns were limited: Arkwright built his mill at Cromford in Derbyshire, Smalley at Holywell in Flintshire, and Oldknow moved from the town of Stockport to the village of Mellor. Cotton-spinning mills driven by water were being set up in Rossendale in 1790,[7] and

[1] Wadsworth and Mann regard the jenny as spinning warp as well as weft, but Unwin states categorically that the jenny could spin only weft (G. Unwin, A. Hulme, and G. Taylor, *Samuel Oldknow and the Arkwrights* (1924), p. 69).

[2] This is the date as given by G. W. Daniels, 'Industrial Lancashire prior and subsequent to the Invention of the Mule', *Journal Textile Institute* (1927). Special issue in association with the Samuel Crompton Centenary Celebrations. The date of the invention is usually stated as 1779. The first mule had 48 spindles; by 1786 there were mules of 100 spindles, and before the end of the century mules of 400 spindles and over.

[3] The significance of the mule is discussed in detail by G. W. Daniels, *The Early English Cotton Industry* (1920), and by T. Midgley, *Samuel Crompton and the Spinning Mule* (1927).

[4] Unwin, Hulme and Taylor, *Samuel Oldknow*, p. 3.

[5] Hamilton, *The Industrial Revolution in Scotland*, pp. 123 *et seq.*

[6] See map of water-power mills in Stockport, 1790–1, in Unwin, Hulme and Taylor, *Samuel Oldknow*, p. 120.

[7] Tupling, op. cit., p. 204.

Samuel Greg built his water-mill at Styal in Cheshire in 1784.[1] The distribution of the water-power factories was probably mainly a rural one.

This water-power phase with its dispersed rural distribution was gradually replaced by a steam-power phase. Coal could be transported, and the site of industry was no longer tied to remote valleys. But many water-power mills installed steam-engines and remained on their old sites. The date of the first application of steam to the cotton industry is uncertain. The late Prof. Unwin placed it at 1789,[2] but Lord's tables show two Boulton and Watt steam-engines at cotton-mills in Nottinghamshire before 1786.[3] Arkwright's water-frame was driven by water-power, the jenny was largely a hand and small factory machine, and it was to the mule that the steam-engine was mainly applied: Watt declared in 1812 that two-thirds of the steam-engines he had erected in cotton-spinning mills were for mules.[4] Mules increased rapidly, owing partly to the much finer yarn which they could spin and owing possibly to this more intimate association with steam-power. In preparation for a petition presented to Parliament in 1812, Crompton investigated the number of spindles in existence in 1811. Including Scotland, the total number of mule spindles was 4,209,570, of water-frame spindles 310,516, and of jenny spindles 155,880. Mules thus constituted 90 per cent of the total spindleage.[5] Baines quotes the returns of a sample of 225 mills for 1833 which employed 20,784 persons on mule-spinning and 2,457 on throstle-spinning (Arkwright's frame when driven by steam), that is, mule-spinners constituted 89·4 per cent of all spinners in this sample.[6] These figures are not intrinsically unlikely for as late as 1907–8 83·6 per cent of the total spindleage of Great Britain was of mules.[7]

Crompton's census was admittedly more complete 'within 60 miles of Bolton' than for other districts of Great Britain. All but 20 per cent of the spindles he enumerated were in Lancashire, Cheshire, and West Yorkshire. Of the Boulton and Watt steam-engines in cotton-mills erected between 1775 and 1800, Lancashire, Cheshire, and West Yorkshire had fifty-six out of ninety-two; that is, 61 per cent. Nottingham, Leicester, and Northampton, the hosiery centres, had 20 per cent, and Scotland had 9 per cent. These figures for 1775–1800 of steam-engines in cotton-mills show a lesser

[1] F. Collier, 'An Early Factory Community', *Economic History*, no. 5 (1930), p. 117.

[2] Unwin, Hulme and Taylor, *Samuel Oldknow*, p. 119

[3] Lord, op. cit., Table I, p. 167.

[4] C. R. Fay, *Great Britain from Adam Smith to the Present Day* (1924), p. 294.

[5] G. W. Daniels, 'Samuel Crompton's Census of the Cotton Industry in 1811', *Economic History*, no. 5 (1930), p. 108.

[6] E. Baines, *History of the Cotton Manufacture in Great Britain* (1835), p. 374.

[7] Returns of the International Federation of Master Cotton Spinners Associations.

concentration into Lancashire, Cheshire, and West Yorkshire as the primary and into the West of Scotland as the secondary region of the cotton industry than Crompton's census of cotton-spinning in 1811. Most, if not all, of the Boulton and Watt engines in the cotton industry were in cotton-spinning, so there is little likelihood of discrepancy between the two sets of figures on that account. Some allowance must be made for the incompleteness of Crompton's figures for the minor cotton-spinning districts, but, even after this is made, it is possible that there was by 1811 a greater concentration of cotton-spinning into Lancashire, Cheshire, and West Yorkshire and into the West of Scotland than there had been in 1775–1800. The steam-engines erected in cotton-mills outside these two regions were mainly in the earlier years of the 1775–1800 period, and of the forty-three installed in the years 1796–1800 all but three were in these two regions. It thus seems clear that, while in the earlier stages cotton-spinning was widely diffused, it rapidly became concentrated in the later stages, particularly after 1795, into Lancashire (with the adjacent parts of Cheshire and West Yorkshire) as the primary and into the West of Scotland as the secondary region.

Of the summary list calculated by Daniels from Crompton's figures, all the spindles in the Lancashire, Cheshire, and West Yorkshire district were in those areas which to-day practise cotton-spinning (see Fig. 13). No spindles are noted north of Rossendale. Cotton-spinning was limited to South-east Lancashire, North-east Cheshire, and, in Yorkshire, the Calder Valley. The distribution within the present-day spinning district showed, as compared with to-day, a much greater emphasis on Manchester, which had nearly one-quarter of the whole, and a much lesser emphasis on Oldham and Rochdale. These last still had their woollen industry. The firms were mostly small, operating on the average 8,161 spindles apiece, but they varied greatly, being of a greater average size in Manchester (15,759 spindles apiece), where there were two firms with over 80,000 spindles each, and being smallest in the Yorkshire districts, Halifax and Todmorden.[1] The average cotton-spinning mill to-day is approximately ten times the size, reckoned in spindleage, of the average in 1811.

The revolution in woollen- and worsted-spinning came later than

[1] Daniels, *Economic History*, no. 5 (1930), p. 109.

FIG. 13

The scale of the symbols is identical in the two maps, the size of the symbol varying in proportion to the number of spindles in each district. The evidence refers to districts and not to towns: the symbol is placed on the site of the town which gives its name to the district. Map constructed from Samuel Crompton's lists as printed by G. W. Daniels, *Economic History*, vol. II, no. 5 (1930).

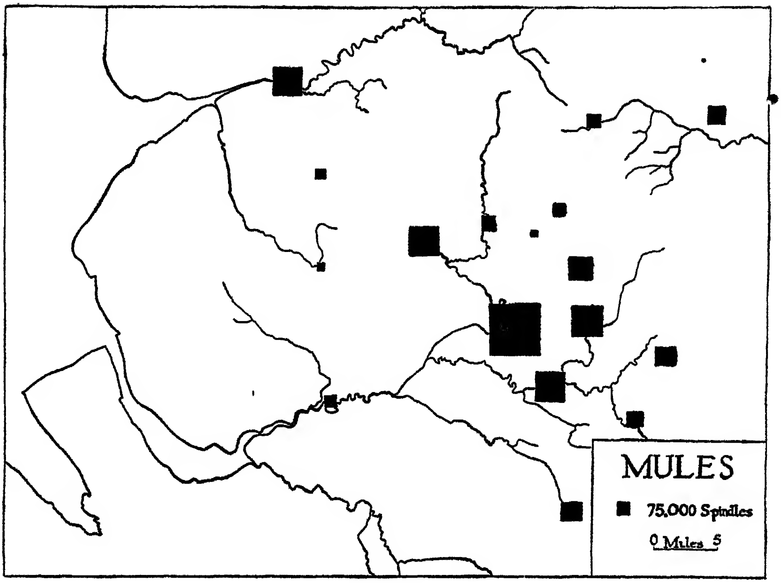


Fig. 13A

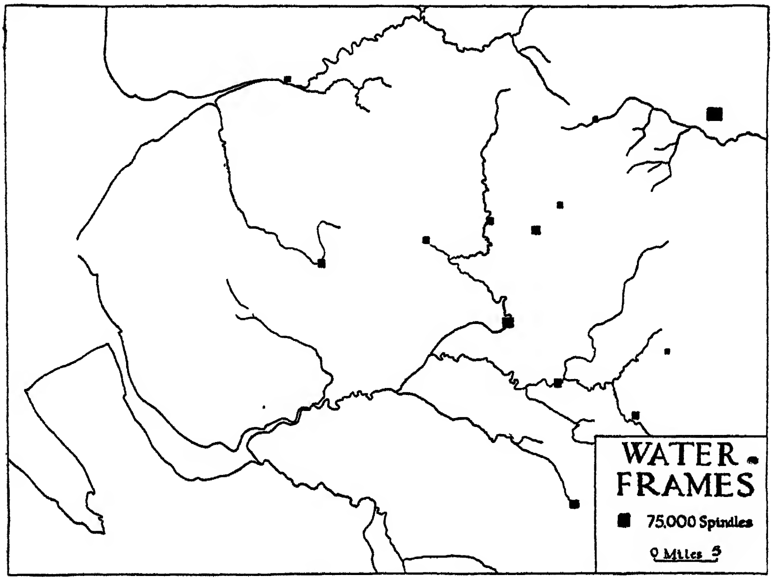


Fig. 13B

MULE AND WATER-FRAME SPINDLES IN THE COTTON INDUSTRY OF LANCASHIRE AND PARTS OF BORDERING COUNTIES IN 1811

in cotton.[1] Cotton was a new industry and it more easily adopted a new technique. It was the worsted industry, which as a considerable manufacture in West Yorkshire was relatively new and which was organized on a more capitalist basis than the West Yorkshire woollen, that earlier adopted power-spinning. There were water-frames spinning worsted yarn at Dolphinholme in Wyresdale in North Lancashire in 1784, at Addingham in Wharfedale in 1787, and at Bradford in 1794. By 1800 there were ten worsted-spinning mills in Bradford. It will be noticed that the earlier mills using the water-frame had a remote rural situation. 'Throughout the early nineteenth century,' W. B. Crump has declared, 'the West Riding could show side by side cotton mills spinning with Crompton's mule, and worsted-spinners using Arkwright's water-frame or throstle (named according as it was driven by water or steam power), whilst the woollen industry retained the hand jenny of Hargreaves both in cottage and factory.'[2] The first yarn factory in Norfolk,[3] the old centre of the worsted industry, was not set up until 1834,[4] by which time worsted power-spinning in Yorkshire was dominant. The West Yorkshire industry was in contact with the inventions in Lancashire close at hand, while East Anglia was remote; moreover, the Norfolk worsted weavers in the eighteenth century had already become dependent on worsted yarn spun elsewhere, in Suffolk and in West Yorkshire itself. It had, therefore, relatively little interest in improving the spinning process. The West Country had hand-jennies possibly earlier than Yorkshire and they appear to have superseded the wheel by 1803. But the adaptation of the power-driven mule to woollen-spinning seems to have taken place earlier in Yorkshire. There was little mule-spinning in the West of England before 1828.[5] The Yorkshire industry adopted power much the more readily.

The transformation of weaving came rather later than that of spinning. It is true that there was the important invention of the wheel shuttle or fly shuttle by John Kay in 1733, but this was an invention somewhat comparable to that of the Dutch smallwares loom in that it speeded up production on the hand-loom. It permitted broadcloth weaving by one weaver instead of the two required hitherto, and it increased the speed of weaving on the narrow loom. The earliest districts to adopt it were Rossendale and Rochdale,

[1] The first 'factory' in the Leeds district was established about 1789 (*Minutes of Evidence*, Committee on Woollen Manufacture, 1806, p. 76), but it is not clear whether power was used at this date nor whether the factory included spinning frames or looms or both.

[2] *The Leeds Woollen Industry, 1780–1820*, ed. by W. B. Crump (Thoresby Society), vol. XXXII (1929), p. 25.

[3] E. Lipson, *The History of the English Woollen and Worsted Industries* (1921), p. 184.

[4] J. H. Clapham, 'The Transference of the Worsted Industry from Norfolk to the West Riding', *Economic Journal*, vol. XX (1910), pp. 197–8, dates it at 1838.

[5] L. C. A. Knowles, *The Industrial and Commercial Revolutions* (1927), p. 52.

which spun wool rather than cotton, and the fly-shuttle was being adopted in West Yorkshire itself by 1763 for certain worsted and half-worsted cloths, though not for all. At the same time that it was being introduced into the woollen and worsted manufacture, it was being adopted extensively in Lancashire in weaving cotton or part-cotton goods. So extensively was it employed in the Lancashire cotton trade that it upset the balance of output between spinner and weaver, the weaver finding it difficult to obtain sufficient yarn for his needs. Machine-spinning was hastened accordingly. The fly-shuttle was not adopted in the West Country woollen industry until the 'nineties, but it had long been used at Colchester in East Anglia, where Kay had settled shortly after his invention in 1733, though it was not adopted in Norwich, a more important weaving centre than Colchester, until after 1800.[1]

TABLE X

Number of Power Looms, 1813–33

	1813	1820	1829	1833
England . .	2,400	12,150	45,500	85,000
Scotland . .		2,000	10,000	15,000
Great Britain .	2,400	14,150	55,500	100,000

From *Reports of Assistant Hand Loom Weavers' Commissioners* (1839–40), p. 591, and Baines' *History of the Cotton Manufacture in Great Britain*, pp. 235 and 237. Whether the figures refer to all power-looms, weaving all textile materials, or simply to looms weaving cotton alone, is uncertain. Compare with Table XI.

The power-loom was a much later invention. Cartwright's loom was patented in 1785[2] and, after improvement, it was in work at Doncaster, driven by a steam-engine, and by 1791 in Manchester. But in neither place was it used for long, and Salte, the London merchant associated with Oldknow in his muslin manufacture at Stockport, wrote in 1787: 'Mr. Arkwright was a happy Mechanic. In his Life time he has received the reward of his Ingenuity—It does not happen so in general. We think Mr. Cartwright will not be equally fortunate.'[3] A really successful loom, by Horrocks of Stockport, was not introduced until 1803, and this was improved by successive patents in 1805, 1813, and 1821.[4] From this date, power-looms rapidly increased in number in the cotton industry (see Table X), and in Baines's day the Horrocks loom was the one in general use. Power-looms were mostly set up by power-spinners

[1] Clapham, *Economic Journal*, vol. xx (1910), p. 207.

[2] Lipson, *Woollen and Worsted Industries*, p. 165. There were subsequent patents in 1786, 1787, 1788, and 1792 (W. Wilkinson, 'Power Loom Developments', *Journal Textile Institute* (1927), Special Issue).

[3] Unwin, Hulme and Taylor, *Samuel Oldknow*, p. 99.

[4] Baines, op. cit., p. 234, and Wilkinson, *Journal Textile Institute* (1927).

who·already had the power and the premises and the experience in managing a power-driven industry. Spinning and weaving were then in the hands of the same firm under the same roof. Table XI gives the number of power-looms in England and Scotland by counties in 1835 in each textile industry. The concentration of power-spinning into the two chief districts, Lancashire and the West of Scotland, has already been noticed as pronounced by 1811, and these particulars of power-looms in cotton-weaving show that it was true of the whole industry. The once extensive hand-loom cotton weaving in the Ipswich district, for example, had only six looms remaining in 1840.[1]

TABLE XI

Distribution of Power Looms in 1835

	Cotton	Woollen and Worsted	Silk	Flax	Total
Lancashire	61,176	1,142	366	—	62,684
Westmorland	—	8	—	—	8
Cheshire	22,491	8	414	—	22,913
Derby	2,403	—	166	—	2,569
Yorkshire	4,039	3,770	—	—	7,809
Stafford	336	—	119	—	455
Devon	—	—	80	—	80
Essex	—	—	106	—	106
Kent	—	—	—	12	12
Leicester	40	89	—	—	129
Middlesex	8	—	—	—	8
Norfolk	—	—	300	—	300
Somerset	—	74	156	—	230
Warwick	—	—	—	—	25
Worcester	—	—	7	—	7
Gloucester	—	4	—	—	4
Montgomery	—	4	—	—	4
Cumberland	186	—	—	—	186
Durham	—	—	—	29	29
Northumberland	—	6	—	—	6
Lanark	14,069	—	—	—	14,069
Renfrew	1,339	—	—	26	1,365
Dumbarton	534	—	—	—	534
Bute	94	—	—	—	94
Ayr	736	—	—	—	736
Kirkcudbright	90	—	—	—	90
Perth	421	—	—	—	421
Aberdeen	248	—	—	142	390
Roxburgh	—	22	—	—	22
Total: England & Wales	90,679	5,105	1,714	41	97,564
Scotland	17,531	22	—	168	17,721
Total: Great Britain	108,210	5,127	1,714	209	115,285

From G. R. Porter, *Progress of the Nation* (1847), p. 204.

[1] *Reports of Assistant Hand Loom Weavers' Commissioners* (1839–40), pp. 350–6.

But considerable numbers of hand-looms weaving cotton did remain in the two chief districts; they were estimated at 220,000 for 1830 and 60,000 for 1844–6. If it be assumed that four hand-looms had an output equal to that of one power-loom,[1] the number of hand-looms in power-loom equivalents would be 55,000 in 1830 and 15,000 in 1844–6.[2] By 1830, then, the power-loom was dominant in the cotton industry and the hand-loom was recessive. The number of hand-looms in the cotton trade had become insignificant by 1856.[3]

The distribution of power-loom weaving in 1841 within Lancashire, already the focus of the industry, presents some interesting features which are set out in Table XII. It is clear that the association of power-spinning and power-weaving in the combined firm was dominant both in South-east and in North-east Lancashire, and that there were more power-looms in South-east than in North-east Lancashire. Only 23·6 per cent of the factory operatives in the cotton industry were in North-east Lancashire and Preston, but, expressed

TABLE XII

Distribution of Operatives in Power-spinning and Power-weaving in Lancashire in 1841

	South-east Lancs	North-east Lancs and Preston	Unspec.	Total
A. Actual Numbers				
Spinning only . . .	53,257	8,411	7,579	69,247
Combined spinning and weaving	65,324	32,654	11,521	109,499
Weaving only . . .	3,794	3,007	1,492	8,293
Total	122,375	44,072	20,592	187,039
B. Percentages				
Spinning only . . .	43·5	19·1	—	37·0
Combined spinning and weaving	53·4	74·1	—	58·5
Weaving only . . .	3·1	6·8	—	4·5
Total	100·0	100·0	—	100·0

From J. Jewkes, 'The Localisation of the Cotton Industry.' *Economic History*, no. 5 (1930) Calculated from *Factory Inspectors' Reports* (1841).

[1] In weaving shirtings, the output of the power-loom weaver was placed as high as six to seven and a half times that of the hand-loom weaver. *Reports of Assistant Hand Loom Weavers' Commissioners*, p. 438. Wilkinson, op. cit., states that the earliest power-looms had an efficiency three and a half times that of contemporary hand-looms, and that by 1835 relative efficiency was ten times as great.

[2] Power-looms at first wove chiefly the coarser fabrics. By 1840 power-weaving had entirely superseded hand-loom weaving of calicoes and fustians at Eccles.

[3] J. Jewkes, 'The Localisation of the Cotton Industry', *Economic History*, no. 5 (1930), p. 92.

as a percentage of the total factory employment in the district, weaving was already *relatively* more important in North-east than in South-east Lancashire. The weaving district of to-day, though it adopted the cotton industry later than South-east Lancashire, and though in 1841 it may have had more power-spinners than power-weavers, was, therefore, just beginning to emerge. Advance figures supplied to Baines by the Factory Inspectors for 1835, though they do not distinguish between spinning-mills and weaving-sheds, show a similar regional distribution of the factory cotton industry. Of 657 mills in Lancashire, 23·0 per cent were in North-east Lancashire, Rossendale, and Preston, and of 137,352 factory operatives 17·4 per cent were in this district.[1] The particulars given by Baines for districts of the number of mills, the number of persons employed, and the steam-power and water-power employed, are sufficiently detailed to permit mapping.[2] Fig. 14 registers the predominant importance of Manchester as in Crompton's census, but Oldham, Bolton, Rochdale, and Bury were rapidly growing. The North-east Lancashire centres had relatively few mills. Some of these northern districts, where the factory cotton industry was not yet established on a large scale, had more water-power than steam-power. This was even truer of the Yorkshire mills, the cotton-mills of Yorkshire having 1,429 h.p. water-power and 956 h.p. steam-power. The Yorkshire mills, as to-day, were much smaller in average size.

The power-loom, like power-spinning, was introduced into the woollen and worsted industries later than in cotton. In 1835 there were in Great Britain, according to Table XI, only 5,127 power-looms weaving wool as compared with 108,210 weaving cotton. Of these, approximately 73·5 per cent were in Yorkshire, 22·3 per cent in Lancashire, 1·4 per cent in Gloucester and Somerset, 1·5 per cent in Leicester, 0·4 per cent in Scotland, 0·9 per cent elsewhere, and none in East Anglia. Over half—58·5 per cent—were in worsted factories, all in Yorkshire. Power-weaving, like power-spinning, was adopted more extensively at this date in worsted than in woollen. A Halifax merchant-manufacturer wrote in 1830: 'With regard to power-looms, . . . Their introduction into the woollen manufacture, (with the exception of worsted stuff goods) has been . . . recent.'[3] The Gott woollen factory in Leeds had power applied to spinning after 1820, but the loom shops still had hand-looms only in 1830. There was a factory and a Boulton and Watt steam-engine in 1792, but power was used only in scribbling, carding, and fulling.[4] Even in the worsted industry the power-loom was not introduced until 1822; this

[1] Baines, op. cit., p. 386.

[2] The returns are for districts and the symbols refer to districts and not to places. Mills were, in fact, more dispersed than the maps would appear to indicate. Thus, Halifax parish had forty-three mills, but many of these were strung along the valleys of the Calder and its tributaries and were not all in Halifax town.

[3] Bischoff, op. cit., vol. II, p. 269.

[4] Crump, op. cit., pp. 1–58.

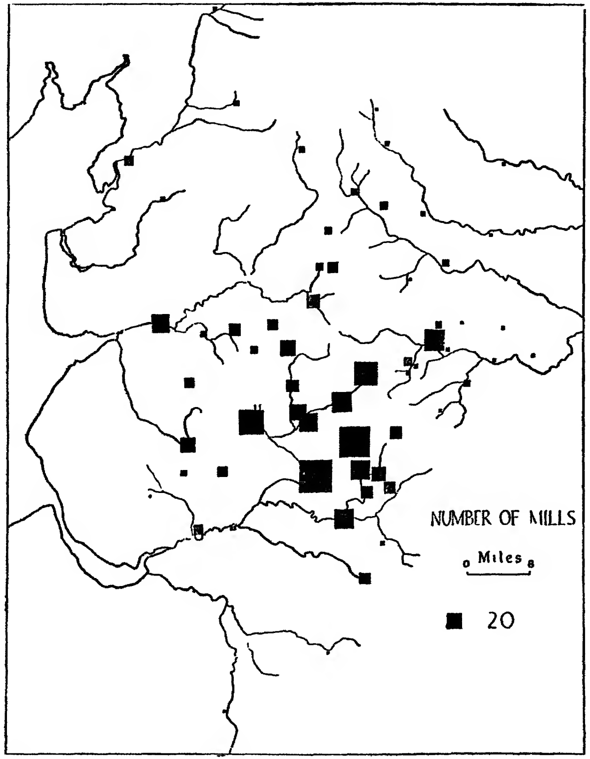


Fig. 14A

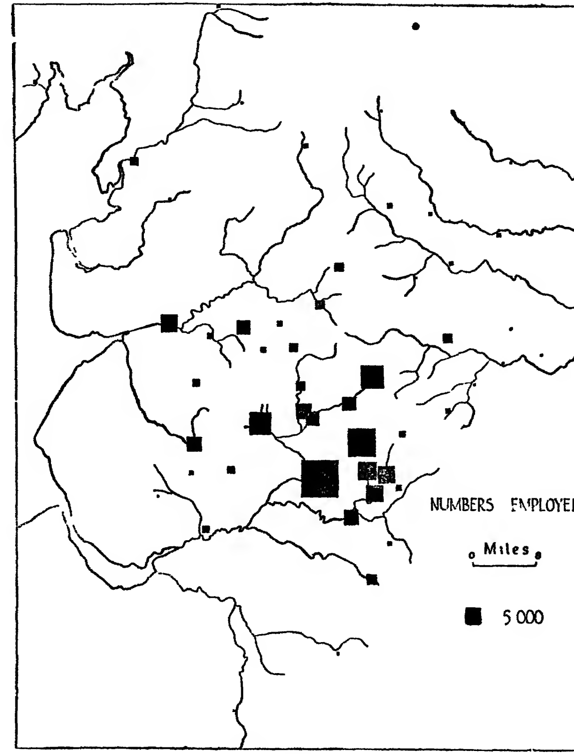


Fig. 14B

COTTON MILLS IN LANCASHIRE AND PARTS OF BORDERING COUNTIES IN 1835. I.

A shows the *number of mills* and B the *numbers employed* in each district, the size of the symbol varying in proportion to the numbers in each case. Maps drawn from returns of Factory Inspectors as listed by E. Baines, *History of the Cotton Manufacture* (1835). These are incomplete for some districts in respect of numbers employed Evidence refers to districts and not to individual places.

was at Shipley, near Bradford.[1] According to the *Reports of the Assistant Hand-loom Weavers' Commissioners*, the first power-loom in Gloucestershire dated from 1836, but Lipson and Porter give four in Gloucestershire for 1835. But, although the power-loom was introduced later in the West Country than in Yorkshire, the collection of hand-looms into loom-shops or factories had long been in progress. In 1840 Gloucestershire had 32 loom-shops with an average of 33 hand-looms apiece. The power-factories, at this date, had few looms unemployed, the loom-shops had more and the cottage hand-loom weavers more still. These relative frequencies are obviously significant. In the same year, Norwich had 656 hand-looms in 'factories' and 3,398 cottage hand-looms. Contemporaries were aware of the more rapid growth of power-weaving in Yorkshire than in the West Country or East Anglia. But, even in West Yorkshire, power-looms did not entirely supersede hand-looms until the middle of the nineteenth century, and the small domestic clothier persisted till this time. There was a great spate of mill building about 1850 in Halifax and Bradford on sites removed from river, canal, and railway.[2] It indicated an urbanized industry, with a nuclear and not a linear distribution.

The adoption of power-weaving registered the final stage in the supremacy of the West Yorkshire industry over the West Country and East Anglia, but it was only the final stage for the decline of the older centres had begun long before this time. Fig. 10 gives the number of pieces of woollen cloth stamped at fulling-mills in Yorkshire from 1726 to 1810. It was admitted by the West Country witnesses to the Select Committee of the House of Lords of 1828 that much of their cloth trade had gone to the North of England.[3] What was equally indicative of the rise of the West Riding industry was the transfer which was taking place from London to Yorkshire as the main site for the organization of the cloth export trade.[4] All this was in 1828 when the power-loom had only just been introduced into the woollen and worsted industries in West Yorkshire.[5] It is clear from some cost of production figures of West Country superfine broadcloth that, while the costs of weaving had remained practically unchanged from 1781–96 until 1828, the costs of spinning had declined from £3 1*s.* 10*d.* in 1781–96 to 1*s.* 9*d.* in 1828 in those cases where the mule was being employed.[6] Power-spinning, adopted

[1] Lipson, *Woollen and Worsted Industries*, p. 187.

[2] On the evidence of dated stones built into factory walls.

[3] *Report*, Select Committee, p. 116. [4] *Report*, Select Committee, p. 305.

[5] The West Country had lost trade to West Yorkshire before this. See *Minutes* of Committee on Woollen Manufacture (1806), p. 29. 'Do you not know that Yorkshire has gained a great deal of the West of England trade? . . . Do you not conceive that the Factory system operates to preserve to Yorkshire that trade drawn from those counties where the trade is not carried on in the same way?'

[6] These figures require some adjustment before they can be taken to refer to strictly the same work, but the difference remains enormous. The figures are abstracted from the *Reports of Assistant Hand-Loom Weavers' Commissioners*.

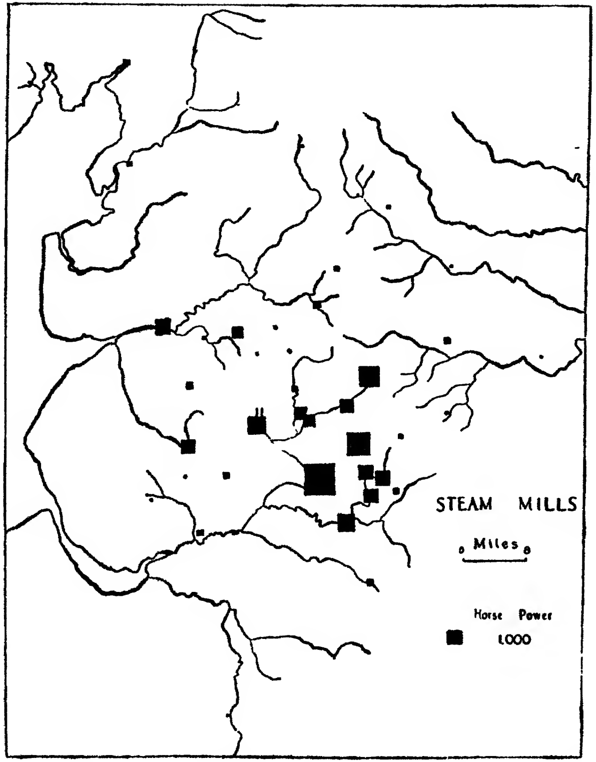


Fig. 15A

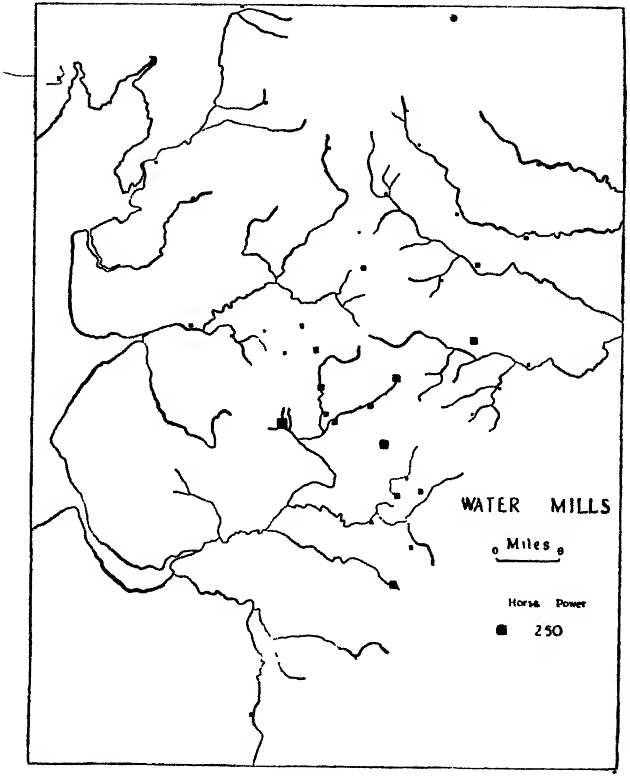


Fig. 15B

COTTON MILLS IN LANCASHIRE AND PARTS OF BORDERING COUNTIES 1835. II.

A shows horse-power in *steam mills* and B horse-power in *water mills* in each district, the size of the symbol varying in proportion to the numbers in each case. Maps drawn from returns of Factory Inspectors as listed by E Baines, *History of the Cotton Manufacture* (1835). Evidence refers to districts and not to individual places.

earlier in the north, gave Yorkshire an earlier advantage. But it was not machinery alone, whether in spinning or in weaving, which was responsible for the change.

'There is not, I believe,' says Clapham, 'any reason to seek novel causes explanatory of the first rise of Yorkshire. It is the ordinary case of a pushing, hard-working locality, with certain slight advantages, attacking the lower grades of an expanding industry.'[1] It may be argued that the 'pushing, hard-working' qualities were rooted in the poverty of the West Riding environment. Whether wages in Yorkshire were lower, as has often been asserted, is uncertain.[2] Indeed, Miss Gilboy finds that wages of labourers and craftsmen other than industrial workers rose substantially during the eighteenth century, and that, though lower than those of the West Country at the beginning of the century, were higher at its close.[3] By 1850–1, Caird found that agricultural wages in the North of England were higher than in the South.[4] Miss Gilboy argues that 'It is not merely coincidence that Yorkshire and Lancashire, which were the centre of industrial expansion in eighteenth century England, were characterized by a laboring class with steadily increasing real wages and economic and social ambition; nor that the western counties, from which the once-important woollen trade was fast disappearing to the north, should possess a poor and unambitious working class. . . . The goad of an expanding standard of life is necessary before labor can be induced to undergo disciplined factory labor'.[5] But, even if wages were no lower in Yorkshire, its cloths were cheaper, although less well-made. West Yorkshire had a more fluid economic and social organization than the West Country or East Anglia. The Yorkshire workman was more ambitious and he oftener rose to fortune. The small clothier organization which persisted beyond the middle of the nineteenth century in the Yorkshire woollen industry was a training ground for advancement.

In addition to these technical, economic, and social factors the West Riding had a number of material advantages for a power-using industry. Coal could be mined at the point of manufacture, and the four main manufacturing towns—Halifax, Leeds, Bradford, and Huddersfield, in the order of their manufacturing population in 1831 —all lay at the contact of Coal Measures and Millstone Grit, where both soft water and coal were available. Moreover, there was fruitful experimental contact between manufacturer and machine-maker, both in the same town.[6] Iron ore was mined from the Lower Coal

[1] Clapham, *Economic Journal*, vol. xx (1910), p. 201.

[2] The evidence taken by the Hand-Loom Weavers' Commissioners was not clear on this point.

[3] E. W. Gilboy, *Wages in Eighteenth-Century England* (1934).

[4] Caird, *English Agriculture in 1850–1*, p. 480.

[5] Gilboy, op. cit., pp. 242–3.

[6] Clapham, *Economic Journal*, vol. xx (1910), p. 203.

Measures and iron-working and engineering industries came to be second in importance only to the textile. These advantages in materials must not be overrated. Much of the Newcastle to London coasting trade was in the hands first of Ipswich and later of Yarmouth ship-masters, and Norwich imported coal. Nor was coal far away from the West Country industry. In the early years of the nineteenth century it was, however, still expensive to transport coal, except by water, and the price of coal away from the Norfolk coast and away from the banks of the Severn would be higher than in the West Yorkshire manufacturing district.[1] The factories used slack, relatively expensive to transport in proportion to its value. By the time the railways were built and inland coal distribution facilitated, the West Yorkshire industry had triumphed: it had an advantage not only in resources, but also in timing. The West Country retained only its superfine woollen broadcloths, in which quality of workmanship rather than cost of production was the chief factor, and East Anglia retained some of its mixed worsted-silk fabrics until they too disappeared. In 1850, West Yorkshire had 87 per cent of the worsted spindles and 95 per cent of the worsted looms, while Norfolk had only 2·3 per cent of the spindles and 1·3 per cent of the looms. Leicester, with its local demand for hosiery yarns, had more worsted spindles than Norfolk, and Lancashire had more worsted looms.[2] By 1850 also, Yorkshire and Lancashire together had 87·4 per cent of the woollen spindles of England and 94·8 per cent of the looms, the West Country 10·2 per cent of the spindles and 4·7 per cent of the looms.[3] The statistics refer in each case to factories alone.[4] Coal did not create the transference to the West Riding, but, applied to machine-power, it confirmed it and stabilized it.

The rise of the Tweed Valley woollen manufacturing district coincided with the Industrial Revolution. In the eighteenth century woollen cloths were made, but in no greater quantities than at Kilmarnock or Stirling, Edinburgh or Aberdeen. Galashiels made kerseys, 'Galashiels greys', an inferior imitation of Yorkshire kerseys. They were from local wool, the Southern Uplands being already a great wool-producing region. Machinery was introduced fairly early: the hand-worked jenny in 1791, the mule in 1814, and the power-loom at Hawick in 1830. By 1840 the hand-loom weavers were

[1] Nef reports very low prices for coal on the banks of the Severn in the seventeenth century—at Tewkesbury in 1678 only one-third of the price in London (Nef, *The Rise of the British Coal Industry*, vol. I, p. 96).

[2] Clapham, *Economic Journal*, vol. xx (1910), p. 210.

[3] Calculated from Fong's abstract of Reports of Factory Inspectors (Fong, op. cit., pp. 64–5).

[4] Woollen manufacture in North Wales also suffered. During the domestic phase it had been widely diffused. The dispersion persisted during the early factory phase when spinning frames and carding engines were driven by water-power. It was only with the rise of steam-power factories that the dispersed distribution gradually disappeared, but not entirely (A. H. Dodd, *The Industrial Revolution in North Wales* (1933), pp. 229–81).

mostly in factories, and the transition to power-weaving was thereby facilitated. The geographical advantages which the Tweed Valley possessed for a woollen industry were local wool and water-power. But the first was unsuitable for tweed-making and it was on tweeds that the industry grew. Water-power was employed during the early years of the machine industry, but the Tweed Valley possessed no monopoly of water-power in Scotland. When steam-power was adopted coal had to be imported. Both local wool and water-power were therefore of only temporary importance. Other possible sites for a woollen industry in Scotland on a substantial scale, however, were devoting themselves to cotton or to linen or to iron and steel. Regional specialization in a single textile material was characteristic of the nineteenth century.

The inventions which transformed the iron industry involved two sets of conditions—first, the substitution of coal for charcoal, and, second, the improvement of the technique of smelting and finishing the iron. It has been pointed out above that raw coal had long been employed to reheat bar iron to render it malleable and capable of being hammered by the smith into goods ready for use. But smelting, the initial separation of the metal from the ore, remained dependent on charcoal despite the experiments of the seventeenth-century ironmasters, of whom the best-known was Dud Dudley. These experimenters possibly did produce iron of some sort with coal, presumably raw coal, but it was probably too brittle for the forge hammer.[1] The use of coal in smelting was first successfully established by Abraham Darby at Coalbrookdale. He was using coke by 1709, as Ashton shows from the entries in *Darby's Journal.*[2] Coke is a purer fuel than coal, just as charcoal is than wood, but its use in the furnace required higher temperatures than charcoal and needed therefore a more powerful blast. It was the provision of more powerful bellows than those in general use that constituted, so Prof. Ashton thinks, the reason of Darby's success. The Coalbrookdale site not only had ore, coal, and limestone in close proximity, but also water transport along the Severn waterway and water-power from tributary streams tumbling into the river at the point of the Coalbrookdale gorge, a deepened glacial overflow channel.[3] Despite the known shortage of charcoal, the use of coke for smelting did not spread rapidly. The early coke iron was suited more to castings than to wrought iron: the greater heat of the coke furnace allowed the metal to run more freely and made possible lighter castings than the fire-backs which was the type of cast iron article produced from the charcoal furnace,[4] but it was unsuited, being too brittle, for working into ploughshares and tools. Darby produced cast wares

[1] Ashton, *Iron and Steel*, p. 12.
[2] Ashton, *Iron and Steel*, pp. 28–31.
[3] L. J. Wills, *Physiographical Evolution of Britain* (1929), pp. 226–8.
[4] Cast iron had been made in England from the sixteenth century.

such as pots, pipes, and kettles, and he was substituting cast iron for brass wherever he found it possible to do so. So difficult was the early coke iron to work by the methods then available to the smith that smiths demanded higher rate of pay in compensation.[1] Until about 1750 coke iron was made only in the Coalbrookdale district and at Bersham, near Wrexham. Both sites retain to-day the semi-ruralism typical of industry at that time. After 1750 it was adopted in Worcestershire, in South Wales (Dowlais), in West Cumberland (Seaton), in Scotland (Carron), and later in South Yorkshire, Northumberland, and elsewhere.[2] Other improvements were one by one introduced—the making of coke in ovens instead of in the open, the substitution of cylinders instead of bellows to give a more continuous blast,[3] the use of the Newcomen engine to assist the water-wheel at times of low water and, in the last quarter of the century, the employment of the Boulton and Watt steam-engine. Cast iron was used for steam-engine parts, and in 1779 the famous Severn bridge at Coalbrookdale, the monument of the early coke iron industry, was completed. In its turn, the steam-engine was applied to the iron industry, first for producing the blast for smelting and later for working the forge hammer.

The second set of improvements, those involving the technique of smelting and finishing, proceeded contemporaneously. The improvements in cast iron consequential upon the employment of coke have already been indicated. Cast steel refined in crucibles was being made at Sheffield after 1742. Although coal had long been employed in smithies and, since 1709, as coke in blast-furnace work, it had not been used in refining pig iron into bar iron; that is, in the refinery between the blast furnace and the smithy. The refinery process was particularly extravagant in charcoal. Coal or coke was used in the refinery by the Cranages in Shropshire in 1766, by Cort at Fontley in Hampshire in 1783–4, and by Onions at Merthyr Tydfil in South Wales. The product was puddled iron. Cort then passed his puddled iron through rollers instead of putting it under the hammer, and greatly increased the volume of production. The amount of work which a hammer driven by water-power could do was limited, but the rollers could deal with fifteen times more iron in the same time. Bar iron suitable for the smithy could now be made entirely by coal or coke, first in the blast furnace and then in a refinery.[4] In 1788, according to a table given by Mushet, there were 208 refineries making bar iron by 'the old method', and these had a total output of 16,400 tons, that is, 79 tons apiece; but there were also 60 melting refineries using coke with a total output of 15,600 tons, that is, 260 tons apiece. These 'old method' refineries

[1] Ashton, *Iron and Steel*, p. 35.
[2] Ashton, *Iron and Steel*, pp. 36–7.
[3] Scrivenor, op. cit., pp. 84–6.
[4] Ashton, *Iron and Steel*, p. 93.

were most numerous in the West Midlands, South Wales, and Yorkshire, Derby and Nottingham.[1] By 1791 the production of puddled and rolled iron alone reached 50,000 tons, a threefold increase in as many years. Puddling and rolling spread northwards from South Wales and the West Midlands to Yorkshire by 1790, to the North-east some years later,[2] and to Scotland perhaps a little earlier.[3]

By the end of the eighteenth century the main outlines of the technical revolution in the iron industry were completed: the industry was freed from dependence on the limited woods and coppices, dependence on which had hampered its growth, and came to be dependent instead on the coalfields, whose resources were ample for an immense multiplication of production. There was, in fact, an immense increase in iron output, as Table XIII shows. The 18,190 tons of 1717, when output was entirely of charcoal iron, became 68,300 tons in 1788, of which 14,500 tons were of charcoal iron and 53,800 tons of coke iron. The production of charcoal iron, though still considerable, was declining.[4] The total output doubled between 1786 and 1796 and doubled again by 1806, by 1839 it was five times the level of 1806 and by 1847 had practically reached two million tons, over one hundred times the output of 1717. This multiplication of production entirely reversed the external trade in iron. At the beginning of the eighteenth century Britain had been importing about two-thirds of the bar iron used in the smithies; but by about 1805 exports of British iron equalled imports of foreign iron, and from that time onwards imports declined and exports increased. Instead of being an importer, Britain became an exporter of iron. The inventions in the technique of iron smelting were paralleled by new uses for iron—as machines for industry, as power-plant for driving industrial machines, as metal fittings for innumerable household purposes, as pipes and standards for urban sanitation and lighting, as railway equipment, and as iron steamships. Iron replaced wood and, to a lesser degree, copper and brass. During the Revolutionary and Napoleonic Wars iron for armaments provided the largest single market and there was depression in the industry when the wars ceased.

But it was not only a technical revolution; it was a geographical revolution as well. The general regional distribution of iron furnaces at several dates is set out in Tables XIII and XIV and of iron forges in Table XV.

These tables permit the distributional changes to be traced with as much precision as the material will allow. In 1717 the county with the greatest number of furnaces was still Sussex, though they were smaller in size than elsewhere. The south-east had a fifth

[1] D. Mushet, *Papers on Iron and Steel* (1840), p. 44.
[2] Ashton, *Iron and Steel*, p. 97.
[3] Hamilton, op. cit., pp. 165–8.
[4] It was 7,800 tons in 1806 and 800 tons in 1839.

TABLE XIII

Distribution of Pig Iron Production, 1717–1847

	1717	1788	1796	1806	1839	1847
A. Quantities (in tons)						
South-east	1,990	300	173	—	—	—
South Wales and Forest of Dean	5,250	15,500	37,300	79,674	472,080	706,680
North Wales and Cheshire . .	2,250	600	3,252	2,075	33,800	16,120
West Midlands .	5,400	31,800	46,180	104,426	445,353	474,240
North-west .	1,000	3,500	2,034	3,991	800	—
Yorks, Derby, Notts . .	2,300	9,600	20,054	37,000	86,788	162,760
North-east . .	—	—	—	—	13,000	99,840
Scotland . .	—	7,000	16,086	23,240	196,960	539,968
Great Britain .	18,190	68,300	125,079	258,206	1,248,781	1,999,608
Average each furnace . .	331	804	1,034	1,493	3,310	4,618
B. Percentages						
South-east .	10·9	0·4	0·2	—	—	—
South Wales and Forest of Dean	28·9	22·7	29·8	31·8	37·8	35·4
North Wales and Cheshire . .	12·4	0·9	2·6	0·8	2·7	0·8
West Midlands .	29·7	46·6	36·9	41·7	35·7	23·7
North-west	5·5	5·1	1·6	1·6	—	—
Yorks, Derby, Notts . .	12·6	14·1	16·0	14·8	7·0	8·1
North-east . .	—	—	—	—	1·0	5·0
Scotland . .	—	10·2	12·9	9·3	15·8	27·0
Great Britain .	100·0	100·0	100·0	100·0	100·0	100·0

Calculated from Table VII and from T. S. Ashton, *Iron and Steel in the Industrial Revolution* (1924), pp. 98, 235–7; H. Scrivenor, *History of the Iron Trade* (1854), pp. 57, 87–8, 95–7, 99, 256, and 295; and 1871 *Coal Report*, vol. III, p. 59. The total production for 1806 includes the output of eleven charcoal furnaces omitted from the regional grouping. The table includes both charcoal and coke pig iron. See also notes under Table XIV.

of the furnaces, but only 10·9 per cent of the output. South Wales, and the Forest of Dean had one-quarter of the furnaces, but 28·9 per cent of the output. The furnaces were here chiefly around the edges of the Forest of Dean, and although some were on the coalfield it was the ore and the surface timber and not the coal of the Coal Measures which was responsible. In the West Midlands, it was Salop and not Staffordshire which had the greatest number. By 1788 there was a marked change. The production of the south-east had become negligible, though it was to persist a little longer.[1]

[1] The Ashburnham furnace closed down in 1828. The extinction of the Weald industry was due to the employment of coke in place of charcoal and not to the extinction of the charcoal resources for charcoal has been made for hop-drying in this century. There were other reasons as well.

TABLE XIV

Number and Size of Iron Furnaces in Districts, 1717–1847

	1717		1788		1796		1806		1839		1847	
	No.	Size	No.	Size	No.	Size	No.	Size	No.	Size	No.	Size
South-east	11	181	2	150	1	173	—	—	—	—	—	—
South Wales and Forest of Dean	14	375	20	775	32	1,166	53	1,943	127	3,717	196	4,680
North Wales and Cheshire	5	450	1	600	5	650	4	692	13	2,600	11	3,204
West Midlands	14	386	33	964	37	1,248	84	1,770	142	3,136	192	3,919
North-west	2	500	6	583	4	509	8	665	—	—	—	—
Yorks, Derby, Notts	9	256	15	640	25	802	46	1,057	36	2,411	58	3,785
North-east	—	—	—	—	—	—	—	—	5	2,600	36	4,160
Scotland	—	—	8	875	17	946	27	1,291	54	3,648	130	6,067
	55	331	85	804	121	1,034	233	1,594	377	3,310	623	4,618

Size is expressed in terms of average actual output per furnace in tons of pig iron. In 1806 and 1847 the statistics distinguish between furnaces in blast and furnaces not in blast: the total number in blast was 162 and 433 respectively. The calculations of average size for these two years refer only to those actually in blast. In other years the calculations refer to all furnaces, for the returns do not distinguish between those in blast and those not in blast. Calculated from statistics printed by T. S. Ashton and H. Scrivenor as for Table XIII and from Table VII. The figures for 1806 include eleven charcoal furnaces omitted from the regional grouping.

TABLE XV

Distribution of Iron Forges in Districts, 1717–88

	1717		1788	
	No.	Per cent of total	No.	Per cent of total
South-east	15	13·0	4	3·8
South Wales and Forest of Dean	29	25·2	28	26·6
North Wales and Cheshire	8	7·0	7	6·7
West Midlands	46	40·0	32	30·5
North-west	—	—	13	12·4
Yorks, Derby, Notts	16	13·9	20	19·0
North-east	1	0·9		—
Scotland	—	—	1	1·0
Total	115	100·0	105	100·0

From Table VII, and from D. Mushet, *Papers on Iron and Steel* (1840).

Though producing more than in 1717, the percentage share of South Wales and the Forest of Dean had fallen, but that of the West Midlands had increased enormously. In 1788 the West Midlands were producing nearly half the total pig iron output and over half (30,000 tons out of 53,800 tons) of coke iron output; of this five-sixths was from Salop. The Forest of Dean still retained a considerable charcoal iron production and its coke iron industry was as yet only beginning. During the next twenty years output increased almost everywhere except in the charcoal iron districts of the south-east and of the north-west. The percentage share of the West Midlands fell slightly from the high level of 1788, but it continued to have the greatest

TABLE XVI

Pig Iron Output in the West Midlands, 1717–1847

	1717	1788	1796	1806	1839	1847
Salop	2,600	24,900	32,969	54,966	80,940	88,400
Stafford	1,450	6,900	13,211	49,460	364,413	385,840

output into the 'thirties, despite the restricted size of its resources. Within the West Midlands, however, the balance of output was changing. Although it was growing continually in Salop in actual quantities, it was growing very much faster in Staffordshire as Table XVI shows. By the middle of the nineteenth century output was coming to bear a closer relationship to bulk of resources than at the end of the eighteenth century. Before the middle of the nineteenth century the West Midlands had been surpassed first by South Wales and then by Scotland. By 1847 these three districts combined were responsible for no less than 86 per cent of the total pig iron output of Great Britain. The supremacy of the coalfields, and of particular coalfields, was clearly accomplished. These were coalfields with a long tradition of metal working, such as the West Midlands, or coalfields where the textile tradition was either weak or relatively fluid, such as South Wales and Scotland respectively. The coalfields of Lancashire and Yorkshire were dominated by their textile manufacture and had no labour to spare. The North-east field was late in the race, partly because of its well-established coasting trade in coal and partly because of the paucity of its resources in Coal Measures ores.

During the first phase of the coke iron industry, then, smelting furnaces were concentrated on the coalfields, where coal and iron ore could both be obtained, often from the same mine. Much of the coal production was from the Lower Coal Measures, where iron-stones are intercalated with coal seams. Iron smelting was localized where ore and fuel could both be obtained on the same

site, but the fuel was now coal instead of charcoal. Of the iron ore mined about 1850, perhaps 95 per cent was of Coal Measure ores.[1] The vertically organized Coal and Iron Company was common. Charcoal iron had required for its production great quantities of charcoal and the early coke iron required similarly great quantities of coal. In 1829 at the Clyde Ironworks the weekly average of fuel consumed for 111 tons of iron was 403 tons of coke (from 888 tons of coal), that is, 8 tons of coal for 1 ton of iron.[2] Although the consumption of coal was not as high in England[3] as in Scotland, smelting was obviously localized on the coalfields. But, with Neilson's invention of the hot blast, the amount of coal required for smelting was greatly reduced. In 1830, when the blast was heated to 300° F., the coal consumed was 901 tons for 162 tons of iron as a weekly average, that is, $5\frac{1}{2}$ tons of coal for 1 ton of iron; while in 1833, when the blast was heated to 600° F., 652 tons of coal were consumed weekly for 245 tons of iron, that is, $2\frac{5}{8}$ tons of coal for 1 ton of iron. The rapid increase of Scottish pig iron production after 1830 is to be attributed partly, at any rate, to the more extended use of the hot blast and to the saving in coal consumption that it made possible.[4] The way was being prepared, through economy in fuel, for changes in the localization of iron smelting later on in the nineteenth century, but as yet smelting was still tied to the coalfields.

There was no such striking revolution in the geographical distribution of forges and refineries. The forges had long tended to be situated in part on the coalfields, where most of the smithying was concentrated even before the beginnings of coke iron manufacture. Even in 1721 the West Midlands had the largest group of forges, and within the West Midlands there were more in Stafford than in Salop, the reverse of the distribution of smelting furnaces. By 1788 the charcoal iron districts had fewer forges than in 1721, but forges were retained more easily than furnaces.

At a later date Ruskin described the iron industry as having 'changed our Merry England into the Man in the Iron Mask', but it was not accomplished immediately, and it had to await the development of an engineering technique. The earliest textile machines were of wood, constructed by carpenters, and even when, as later, they came to be made of iron, each part had to be forged separately; after the machine had been assembled it was often some time before it could be got to work. It was the same with other machines as well as the textile. In the second quarter of the nineteenth century methods for exact measurement of machine parts and the elaboration

[1] Ll. Rodwell Jones, *North England* (1926), p. 246.
[2] Scrivenor, op. cit., p. 260.
[3] Mushet placed it at 5 tons of coal to 1 ton of iron in Staffordshire in 1810.
[4] Scrivenor, op. cit., pp. 259–61. Also Clapham, *Early Railway Age*, pp. 425–6. The use of blackband ores in Scotland was another factor: they contained so much 'coaly' material that the consumption of coal was greatly lessened.

of machines 'to make machines' were gradually worked out,[1] but machine tools did not become part of the standard equipment of engineering firms until about 1850. What may be termed the handicraft phase of British engineering was passing away and the engineering firm was growing rapidly in size.[2] It was now possible for machines each exactly alike to be made in indefinite numbers, and it was possible to produce them much more cheaply and expeditiously than hitherto. The stage was set for the mechanical age.

The technical revolution in the methods and the geographical revolution in the site of industrial production proceeding throughout the range of British industry, though the treatment above has been limited to samples, were dependent on three sets of conditions:

(*a*) The provision of sufficient quantities of coal. If the new age was an iron age, it was also a coal age. The domestic fire and oven, the manufacture of iron, engines, and machines, the driving of machines in industry and of machines for transport on land and sea—all were dependent on coal, whether directly or indirectly in the form of steam or gas. The rapidly multiplying consumption of coal gave rise to fears of the adequacy of supplies for the future, fears later crystallized by Jevons in his famous analysis of 1865. Contemporaries were all aware of the influence of coal on industrial localization. 'The seat of various manufactures,' writes Porter, 'having in great part been determined by the presence, in certain districts, of cheap fuel, and the growth of population having by that means been greatest in or near to some of our principal coal-fields . . .'[3]

(*b*) The provision of an adequate labour force. The population of Britain was increasing during the period of the Industrial Revolution, but the rate of population growth and the rate of growth of demand for labour did not always coincide. There was, as Prof. T. H. Marshall puts it, 'a failure of economic progress and the increase of numbers to keep step together'.[4] Perhaps for the country as a whole population growth outpaced 'economic progress',[5] but in particular districts population was insufficient to meet the demand for labour. Most of the rising industrial districts, where the demand for labour was greatest, were in those parts of the country which had been scantily peopled during the Middle Ages. The relative shortage of labour in these districts may have been responsible for high wage rates and for an early introduction of machinery to

[1] Clapham, *Early Railway Age*, pp. 446–9. Also Hamilton, op. cit., pp. 207–10.
[2] Clapham, *Early Railway Age*, pp. 448–9.
[3] G. R. Porter, *The Progress of the Nation* (1847), p. 281.
[4] T. H. Marshall, 'The Population Problem during the Industrial Revolution', *Economic History*, no. 4 (1929), p. 438.
[5] Marshall, op. cit., pp. 436–8.

increase production per unit of labour in order to offset the labour shortage and so to intensify and accelerate the progress of the Industrial Revolution. Whether this was so or not, the regional variation of labour demand was a factor of great importance.

(c) The improvement of transport. The Industrial Revolution coincided with, indeed called forth, a revolution in the means of transport. Road surfaces were improved, canals were dug and railways were built. It may be argued with some truth that transport improvement in Britain lagged behind the need of it. Improvement was indeed always due to the efforts of local men anxious to solve a local problem, whether the improvement was a turnpike road, a canal, or a railway. Josiah Wedgwood, for example, was one of the chief promoters of the Trent and Mersey Canal. The rising industrial districts, drawing in raw material from outside and sending finished manufactures back into the outside world, could breathe only if their channels of communication were kept clear.

The growth of coal production and the growth of population will be considered further in this chapter, but the improvement of transport will be treated in the next.

The revolution in coal-mining began early in the eighteenth century. Before this time the bell-pit and the adit had been the common methods of working coal, though shafts had been sunk in the North-east field to 400 feet.[1] The average number employed even in this field, however, may have been no more than forty per pit, and in most districts six to twelve or less was more usual. The small-scale working was due to difficulties of drainage and ventilation. A hillside position permitted natural drainage, of which the collier took full advantage, but a low-lying pit was dependent upon mechanical drainage. Water-wheels were used in the North of England particularly, and from 1711 to 1717 onwards the Newcomen engine, and from 1776 the Boulton and Watt engine, were applied to supply the water-wheel with water or to work the pumps direct. By the beginning of the nineteenth century mining, in consequence, had reached a depth of 993 feet in West Cumberland, and by 1838–40 of 1,392 feet in South Lancashire and 2,100 feet in North Staffordshire.[2] There were systems of ventilation during the eighteenth century, but the solution of the problem of fire-damp was not in sight until 1816, when the safety-lamp first came into use.[3] But the problem of fire-damp was not solved, for the safety-lamp was used to permit the mining of seams hitherto considered too dangerous to work. These advances in the technique of coal-mining made possible

[1] Ashton and Sykes, op. cit., p. 10.
[2] Clapham, *Early Railway Age*, p. 435.
[3] Ashton and Sykes, op. cit., pp. 52–3.

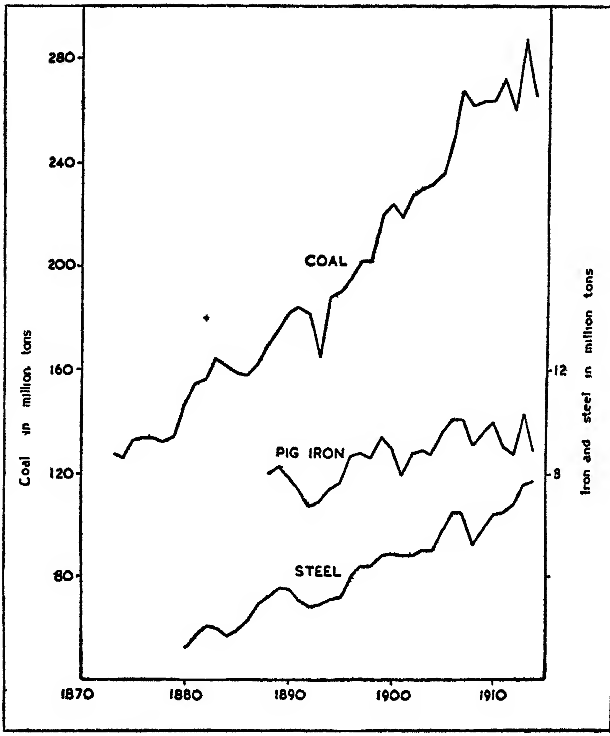


Fig. 16

OUTPUT OF COAL, PIG IRON AND STEEL IN GREAT BRITAIN TO 1914

the greatly increased output which the Industrial Revolution demanded.[1] The Royal Commission on Coal which reported in 1871 estimated production in 1770 at over 6 million tons and in 1800–1 at over 10 million tons. It rose rapidly during the first half of the nineteenth century as the demands of industry, transport, and domestic consumption increased, and by 1854, the date of the first statistical returns, it had reached 65 million tons. Jevons assumed on the basis of the 1854–64 decade a rate of increase of 3½ per cent annually,[2] and Clapham attempts a reconstruction of the course of coal production in 1770–1856 as a steepening curve.[3] Jevons insisted 'both from

[1] The long wall system of coal-getting gradually spread during the eighteenth century from Salop, where it originated early in the seventeenth, to other fields in the West Midlands (in the early eighteenth) and to Derbyshire, Lancashire, and Scotland (in the late eighteenth). Where surface and roof conditions permitted its employment, the long wall was the most economical method and permitted the extraction of the maximum quantity of coal (Ashton and Sykes, op. cit., pp. 14–32).

[2] W. S. Jevons, *The Coal Question* (1865), 3rd edition, ed. by A. W. Flux (1906), p. 269.

[3] Clapham, *Early Railway Age*, p. 431.

principle and fact, that a nation tends to develop itself by multiplication rather than addition—in a geometrical rather than an arithmetical series. And though such continuous multiplication is seldom long possible, owing to the material limits of subsistence . . . up to the present time (1865) our growth is unchecked. . . . Now while the iron, cotton, mercantile, and other chief branches of our industry thus progress, it is obvious that our consumption of coal must similarly progress in a geometrical series. This, however, is matter of inference only'.[1] His worst fears were not realized.

TABLE XVII

Regional Coal Production in Great Britain in 1855

	No. of collieries	Output Tons	Output per colliery Tons
Northumberland and Durham	272	15,431,400	56,733
Cumberland	23	809,546	35,198
Yorkshire	333	7,747,470	23,266
Derby	171	2,256,000	13,193
Nottingham	20	809,400	40,470
Warwick	17	262,000	15,412
Leicester	11	425,000	38,636
Stafford	500	7,323,000	14,646
Lancashire	357	8,950,000	25,070
Cheshire	32	755,500	23,609
Salop	56	1,105,250	19,558
Gloucester and Somerset .	86	1,430,620	16,633
North Wales	65	1,125,000	17,308
South Wales	245	8,550,270	34,899
Scotland	403	7,325,000	18,172
Great Britain	2,591	64,305,456	24,820

From R. Hunt, *Mineral Statistics of the United Kingdom for 1855* (1856).

It is not possible to state with any exactitude the precise share of each coalfield in this expansion of production. The first statistics were not collected until 1854.[2] Output in 1855 is set out field by field in Table XVII. The Northumberland and Durham field had then still the largest production of any single British coalfield. The factors which promoted its development before the Industrial Revolution still continued to operate. The vend of coal from the north-east ports, of which a record exists, for it was subject to dues, was 2½ million tons in 1800. The import of London alone was 1 million tons in 1800 and over 3½ million tons in 1850. The regional markets served by British fields were delimited in the *Report* of the Select

[1] Jevons, op. cit., p. 261. He contended that this geometrical increase would, in fact, not persist, and that the curve would, at some time in the future, flatten itself out.

[2] R. Hunt, *Mineral Statistics of the United Kingdom for 1854*.

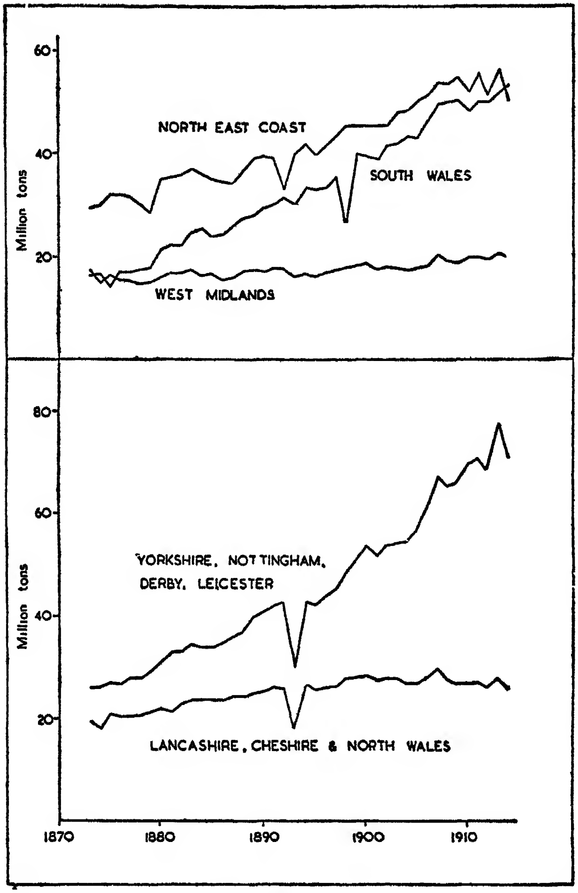


Fig. 17

OUTPUT OF COAL BY FIELDS, 1873–1913

Committee on the State of the Coal Trade in 1830. The North-east coalfield had a virtual monopoly of the coal trade along the whole of the east coast and along the south coast as far west as Plymouth. There was some competition with Yorkshire coal from the Humber and with West Midland coal brought by the Grand Junction Canal into London,[1] but neither was substantial. Parts of North England and of the East Midlands formerly supplied by sea from the North-east field were being furnished from inland fields along canals by 1816.[2] Not only had the North-east field the largest share of the coastwise trade, but it also contributed the largest proportion to the

[1] Canal-borne coal was only 1,484 tons in 1826. [2] Porter, op. cit., p. 282.

export trade. Export in 1850 has been estimated at 3·8 million tons, and the share of the North-east ports at 63·6 per cent.[1] The greater part of the output of this field was of household coal. It was not until the 'thirties that the steam coals of Northumberland north of the Ninety Fathom Dyke, and it was not until the 'forties that the coking coals of South-west Durham, came to be won on any considerable scale. The first shaft sunk through the Magnesian Limestone in East Durham was in 1821, but the output of this shaft was of household and not of gas coal. New miners were drawn in from outside the coalfield, from the lead-dales of the Northern Pennines, from Scotland, Wales, the Midlands, and elsewhere, and these swamped the old aristocracy of the Tyneside pitman with a relatively high standard of work and a relatively high standard of living based on the monopoly of the London market.[2]

South Wales had a smaller output. Even by 1855 it was producing little more than half as much as the North-east and was surpassed by Lancashire. There were relatively few deep workings in South Wales and there were more adits than pits in 1841–2.[3] It had never been as important in the household coal trade as the North-east field. The anthracite of the western part of the field was worked first, and this was useless for the then domestic fire. The bituminous district, though it produced household coal, was hampered by its inland situation, being much farther inland than the Tyneside pits. This eastern district was not worked at all extensively until the iron-masters, in search first of charcoal and then of coke, settled in the valleys along the north-east rim of the coalfield—Merthyr Tydfil, Aberdare, Dowlais. In 1828 the iron industry consumed 1½ million tons, over half the total production of approximately 2¾ million tons.[4] An export was beginning to develop from the eastern ports, particularly Newport, the port of the eastern valleys. In 1828 Newport and Cardiff contributed 459,986 tons out of a total export from South Wales of 904,896 tons,[5] and in 1855, 1,869,948 tons out of a total shipment (coastwise and foreign) of 2,897,579 tons. The centre of gravity was shifting from the western to the eastern ports of the South Wales littoral. Nevertheless, this export was much less than that of the North-east field: the Bristol Channel ports in 1850 contributed 13·3 per cent of the total coal export of Britain, while the North-east coast contributed 63·6 per cent.[6] It was not until 1880 that the South Wales export equalled that from Northumberland

[1] D. A. Thomas, 'The Growth and Direction of our Foreign Trade in Coal', *Journal Royal Statistical Society* (1903), pp. 440 and 498. The export from this field had been only 260,314 tons in 1821 (Jevons, op. cit., p. 313).

[2] Welbourne, op. cit., pp. 46–9.

[3] Clapham, *Early Railway Age*, p. 433.

[4] E. J. Jones, *Economic History of Wales* (1928), p. 67.

[5] *Report of the Commissioners ... Coal in the United Kingdom*, vol. III (1871), p. 50.

[6] Thomas, op. cit., p. 498.

and Durham, a growth based on steam coal, mined in the central part of the field and exported from Cardiff.

The Lancashire field ranked third in output. Cotton-mills and coal-pits lay close together, and coal was used in quantity by numerous textile and general engineering shops and by the thickly spread industrial population, as well as by the cotton-mills themselves. By the middle of the nineteenth century the cotton industry had become wholly a machine industry and wholly dependent on coal. The Liverpool bunker market and export to Ireland also took coal from the western end of the field. Of the West Midland fields the most important were in South Stafford, North Stafford, and at Coalbrookdale. South Stafford and Coalbrookdale were associated with the rapidly developing metal industries: one-third of the Salop and one-third of the Stafford output was consumed in blast furnaces. Coalbrookdale still retained some of its shipment along the Severn, its most important market prior to the Industrial Revolution, but Staffordshire coal was all consumed in the district, and some special qualities were drawn in from other fields; for example, gas coals from North Wales. The Warwickshire and Charnwood Forest fields were worked to a much lesser extent, but their coals were distributed southwards and eastwards by canal as far as Oxford and Reading.

The Yorkshire, Derby, and Nottingham field produced over 10 million tons, and was the second field in the country on the basis of output. Its northern, or Yorkshire, part was the more important. This was the most industrialized district, with woollen and worsted industries, textile and general engineering, cutlery and hardware. It had also the largest domestic consumption. The Derbyshire part of the field had ironworks, then as now, and Nottingham had an industrial demand from textile industries. There was also a not inconsiderable quantity distributed by rail away from the coalfield. The 1830 map shows the regional market of the York–Derby–Nottingham field as extending from Nidderdale and the Vale of Pickering to Northampton and Boston. In addition, some coal was sent to London from the Yorkshire field, but the Nottingham field, despite attempts from the late sixteenth century onwards, did not send coal regularly.[1] This mining before 1850 was entirely in the exposed coalfield, and in Nottingham the first shaft through the Permian and Trias cover into the concealed field was not sunk until 1854. The 'inland coal' of this field, particularly of the Yorkshire portion, was pushing back towards the coast the market supplied by sea from the North-east coalfield. At Wisbech the depth of country supplied by the coasting trade had been reduced from 60 miles to 40.[2]

[1] H. Green, 'The Nottinghamshire and Derbyshire Coalfields before 1850', *Journal Derbyshire Archaeological and Natural History Society*, no. 56, p. 60.

[2] *Report and Minutes of Evidence*, Select Committee of the House of Lords on the State of the Coal Trade (1830), p. 98.

Coal-mining in Scotland increased parallel with the growth of Scottish industries and of the Scottish industrial population. Coal superseded peat as a domestic fuel except in the Highlands, and it was used for the usual range of industrial purposes. The consumption of coal in ironworks had been estimated to be approximately 250,000 tons in 1812,[1] but 2½ million tons in 1855 in the West of Scotland alone;[2] there had been an immense increase in iron production in the interval. The domestic, manufacturing, and bunker consumption in the West of Scotland in 1855 was placed at nearly 3 million tons. The shipment of coal, coastwise and abroad, had also increased. By 1855 it had reached nearly a million tons. From the Firth of Forth ports shipment coastwise was mainly to other parts of eastern Scotland, but more was sent abroad, to Baltic and North Sea markets. From the Clyde and Ayrshire coasts shipment coastwise was mainly to Northern Ireland, and export abroad (a minor feature of its shipment trade) was mainly across the Atlantic. The difference in space-relations between east and west coast ports is clear. Up to the Industrial Revolution the greater bulk of the production was close to the coast, but with the growth of an internal domestic and industrial market and with the improvement of internal communications, mining spread into interior districts.[3] There was also a change in the balance of development between the eastern and the western fields. Hitherto output had been greatest in the eastern districts, prior to the Industrial Revolution economically the most important part of Scotland. But with the growth of the textile and of the iron industries of the West of Scotland and with the development of the Lanarkshire field, the largest of all Scottish coalfields, the balance of output changed. In 1855 the West of Scotland had two-thirds of the collieries of Scotland[4] and nearly three-quarters of the output of coal.[5]

The second conditioning factor in the progress of the Industrial Revolution was the labour force. Not only was coal required to drive the machines, but labour also to man them. The opinion was widely held in the late eighteenth century that the population of the country was declining.[6] There seemed some doubt whether the demand for labour would be met adequately by the supply. The early census returns refuted this contention and proved that the total population of the country was not declining, nor even stationary, but was rapidly increasing. It is probable that the period of rapid increase was mainly during the hundred years, 1750–1850, and that it coincided in fact with the Agrarian and Industrial Revolutions. Although all

[1] Hamilton, op. cit., p. 172. [2] *Mineral Statistics for 1855.*

[3] For this movement in the Ayrshire field see maps for 1793 and 1840 in J. H. G. Lebon, 'The Development of the Ayrshire Coalfield', *Scottish Geographical Magazine*, vol. XLIX (1933).

[4] Hamilton, op. cit., p. 191. [5] *Mineral Statistics for 1855.*

[6] Clapham, *Early Railway Age*, pp. 53–4 for a summary.

figures of population prior to 1801 are uncertain estimates, the following, extracted from the *Report* on the Census of 1851, summarize the position. For *Great Britain* the total population was estimated at 6,378,000 in 1651, 7,392,000 in 1751, and 21,185,000 in 1851;[1] that is, an annual increase (if the figures will bear the calculation) of 0·16 per cent in the 100 years 1651–1751 and of 2·87 per cent in the 100 years 1751–1851. The most rapid rate of increase was subsequent to 1775,[2] culminating in the decade 1811–21. In general terms it may be said that this threefold increase of population was a response to the multiplication of the wealth of Britain, agricultural and industrial, made available by the Agrarian and Industrial Revolutions. Improved agricultural and industrial technique set free resources inherent in the physical environment, but hitherto unutilized or only partially utilized.

This much can be said with some confidence. But, when the attempt is made to analyse the mechanics of this increase, to express the relative share of the birth-rate, the death-rate, and the migration-rate, and to trace the relationship between increase on the one hand and economic and non-economic motives on the other hand, the position is much more uncertain. Some attention has been directed to this problem.[3] There was an increase in the crude birth-rate and in the corrected birth-rate: the increase began after 1780, but it was beginning to die away after 1821. There was a decrease in the death-rate which was progressive until 1821, after which it appears to have increased again slightly. Prof. Marshall accepts this increase as real,[4] but Mrs. Hammond shows that in the particular case of Manchester the appparent increase was due to defective statistics of the census years prior to 1831, when many burials were not registered.[5] The death-rate was greatest among infants and in the towns, and the decline in the crude death-rate was largely due to decreased mortality among newly-born infants and to improved sanitation and cleanliness in the towns. There is no exact correspondence between the decennial trends in birth-rates and death-rates on the one hand and prices, wages, and prosperity on the other.[6] Changes in birth-rates and death-rates seem to be more clearly related to social changes, which were themselves, however, often indirectly related to the

[1] *Census of 1851. Population Tables II. Ages, Civil Condition, Occupations, and Birth-Place of the People, Report*, vol. I (1854), p. li. For the eighteenth-century population of England, see E. C. K. Gonner, 'The Population of England in the Eighteenth Century', *Journal Royal Statistical Society*, vol. LXXVI (1913).

[2] Gonner, op. cit., p. 285.

[3] See G. T. Griffith, *Population Problems of the Age of Malthus* (1926); T. H. Marshall, 'The Population Problem during the Industrial Revolution', *Economic History*, no. 4 (1929); T. H. Marshall, 'The Population of England and Wales from the Industrial Revolution to the World War', *Economic History Review*, vol. V, no. 2 (1935).

[4] Marshall, *Economic History*, no. 4 (1929), p. 454.

[5] B. Hammond, 'Urban Death-Rates in the Early Nineteenth Century', *Economic History*, no. 3 (1928).

[6] Marshall, *Economic History Review*, vol. V, no. 2 (1935).

economic. The decline in handicraft industry, for example, reduced the incidence of apprenticeship and of living-in: the average age of marriage was reduced and the effective child-bearing years of the mother increased.[1]

This is a general statement for the country as a whole, but there was considerable regional variation. The increase in the total population was not evenly distributed. It was least in East Anglia, the West Country, and the rural counties of the East Midlands. The former were losing their industrial pre-eminence to the North of England, and the latter, which included much clay land, were changing from arable to grass or, where arable remained, were economizing in labour. Increase was greatest in the industrial districts of the North of England, the West Midlands, and South Wales. Arranged according to density of population, the first five counties in 1700 were Worcester, Somerset, Devon, Lancashire, and Gloucester, but in 1801 Lancashire, Warwick, the West Riding, Stafford, and Gloucester.[2] The scatter of counties in 1801 was between a much wider range of densities than in 1700: in 1700 the county with the lowest density had 54 per square mile and the county with the highest density 141, but in 1801 the highest and lowest densities were 353 and 55 respectively. The lowest densities had not changed, but the highest had grown two and a half fold. There were regional differences, too, in birth-rates and death-rates, as might be expected from these differing rates of increase. Porter gives tables showing the proportion to the total population of births and deaths for the individual years, 1839–42, for each county of England.[3] The crude birth-rate was above the average for England as a whole in Lancashire, the West Riding, Northumberland, Durham, Monmouth, Bedford, Berkshire, Cambridge, Hertford, Leicester, Northampton, Nottingham, Worcester, and Cornwall. The list includes the most rapidly developing manufacturing districts and the most rapidly developing coalfields, but it also includes enigmatically a group of Midland counties in the very heart of the district latest to be enclosed. The counties with crude birth-rates well below the average for the country as a whole included most of the West Country, East Anglia, the Welsh Border, and some hill counties in the North of England. These were areas of declining industry or areas of hilly land from whence population was migrating, attracted by industrialism near by, and where, it may be presumed, population had a relatively small proportion of young married couples. The death-rate was above the average for England in Lancashire, Durham, Monmouth, Middlesex, Surrey, and Worcester. It was, therefore, in rapidly developing urban and mining districts that the death-rate was greatest. The rural areas

[1] Marshall, *Economic History Review*, vol. v, no. 2 (1935), p. 69. On the assumption that the wife was of approximately the same age as the husband.

[2] Gonner, op. cit., p. 287.

[3] Porter, op. cit., p. 34.

had a death-rate below the average. They were regarded as the healthy reservoirs from whence the ravages amongst the town population were repaired. Regional variations in birth-rates and death-rates alone do not explain regional changes in population density. A vast amount of internal migration was in progress in response to changes in the distribution of economic opportunity.

Internal migration within England during the period of the Industrial Revolution has been examined by Prof. Redford.[1] The first detailed statistical record is in the birthplace tables of the 1851 census, but Redford uses also scattered references in earlier census reports and in contemporary literature. The *Report* on the Census of 1851 stressed the volume of this internal migration and calculated that 'of the 6,589,048 inhabitants of London and of sixty-one English and ten Scotch towns, 3,598,891 are natives and 2,990,157 are settlers who were born in other parts. But of the 3,767,626 persons of the age of 20 and upwards, only 1,477,949 were born in the towns, while 2,289,677 were born in other parts'.[2] These figures are eloquent. Of the population of these towns, only 54·6 per cent were born there, and of those aged over twenty only 39·2 per cent were born there. It was, of course, the towns which were the chief recipients of the flow of population. Prof. Redford has affirmed that internal migration was essentially of a short-distance character.[3] 'The majority of the migrants to the town came from the immediately surrounding counties, their places in turn being taken by migrants from places further away.'[4] In respect of the population aged over twenty, of the immigrants into Lancashire over two-thirds came from adjacent counties and from Ireland; of the immigrants into London, few came from beyond the English Plain, and it was from the Home Counties that most were drawn.[5] There was comparatively little transference of population from south to north, from the declining to the rising industrial districts. A few migrated from East Anglia and the West Country into the West Riding (chiefly from East Anglia), but the hand-loom weavers displaced from the declining centres in the English Plain were not needed in Yorkshire, which had its own unemployed hand-loom weavers to absorb. Emigrants from East Anglia and the West Country went mainly to London

[1] A. Redford, *Labour Migration in England, 1800–50* (1926). For movement from and into a particular county see H. C. Darby, 'The Movement of Population to and from Cambridgeshire between 1851 and 1861', *Geographical Journal*, vol CI (1943).

[2] *Census of 1851. Population Tables II, Report*, vol. I (1854), pp. cv–cvi.

[3] This was more nearly true of the period prior to 1850, of the time when movement was primarily from country to town: but the greater mobility given by the railway and the increasing movement between town and town permitted longer distance migration which became increasingly significant after 1850. These are the conclusions arrived at by R. Lawton from an analysis of the census data.

[4] Redford, op. cit., pp. 158 and 160.

[5] *Census of 1851. Population Tables II*, vol. I (1854), Summary Tables, Table XXXIX. See also Redford, op. cit., Maps D and E.

and South Wales respectively and were recruited into occupations other than the textile. There was rather more migration of miners and of metal-workers, whose skill could be utilized in other districts. North Pennine lead-miners entered the coal-pits of Durham, Cornish tin-miners those of South Wales, Derbyshire lead-miners those of the Midlands; ironmasters and iron-workers dispersed from Shropshire to the Black Country and South Wales. But the greater part of migration was not of skilled men continuing to practise their craft in a new region, but of young men and women largely untrained in industry. They either entered the mill or workshop or undertook carting, building, or domestic service, ancillary occupations associated with the growing industries and the growing urban population. Their children were absorbed into industry more readily. But while there was little long-distance migration from south to north, the counties of the English Plain exported much of their population. The *Report* on the Census of 1851 lists the following counties as having a substantial excess of emigrants over immigrants: Norfolk, Suffolk, and Essex; Wiltshire, Somerset, Dorset, Devon, and Cornwall; Hereford and Shropshire; Berkshire, Oxford, Buckingham, Hertford, Northampton, Leicester, Lincoln, Derby, and Kent.[1]

The result of these movements on occupational distributions is summarized by the occupation tables of the census returns. Already in 1811 there were more families in trade and manufacture than in agriculture in England and Scotland, though not in Wales. There were, of course, regional differences within each country and within each county. On this classification, the English industrial counties were Northumberland and Durham; Lancashire, Cheshire, and the West Riding; Stafford and Warwick; Nottingham, Leicester, and Gloucester; Middlesex and Surrey. Lancashire and the West Riding headed the list in the proportion that families engaged in trade and manufacture bore to the total number of families.[2] From 1831 the occupational classification was more detailed, and by 1851 an elaborate classification had been adopted. Some of these 1851 categories, calculated as percentages of the total male population of twenty years and over, have been mapped (see Fig. 18). Of the male population of Great Britain in 1851 of twenty years and over, 27·2

[1] Extra-metropolitan Kent.

[2] Porter, op. cit., table p. 58.

Fig. 18.—As percentages for each registration county of England and Scotland of males aged 20 years and upwards.

The textile, coal and metal maps have identical keys and are exactly comparable. Owing to greater percentage densities it was not possible to have an identical key for agriculture. Wales is omitted.

The maps display clearly marked regional economic specialisms, even on a county basis—textile manufacture in Lancashire and Yorkshire, Selkirk, Renfrew, Fife and Forfar; metal working in the West Midlands, West Riding, South Wales and Lanark; agriculture in the English Plain, Welsh Border, the Scottish Border and the Scottish Highlands.

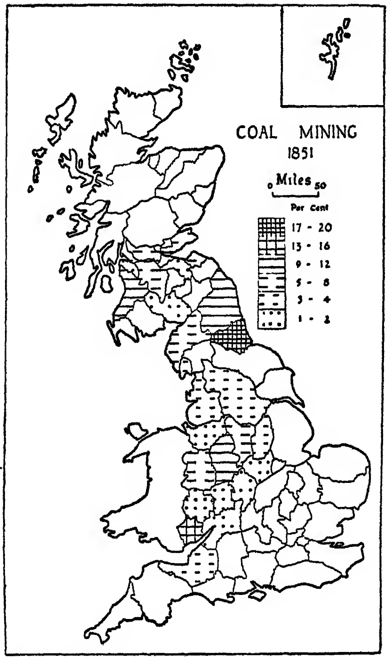


Fig. 18A

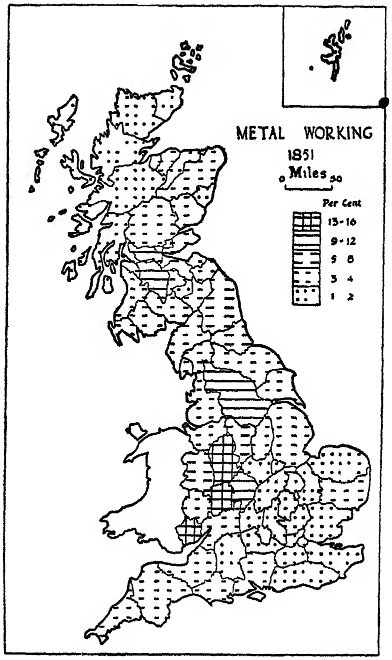


Fig. 18B

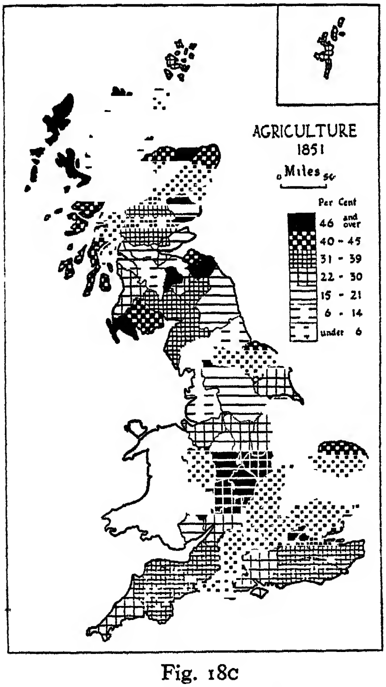


Fig. 18C

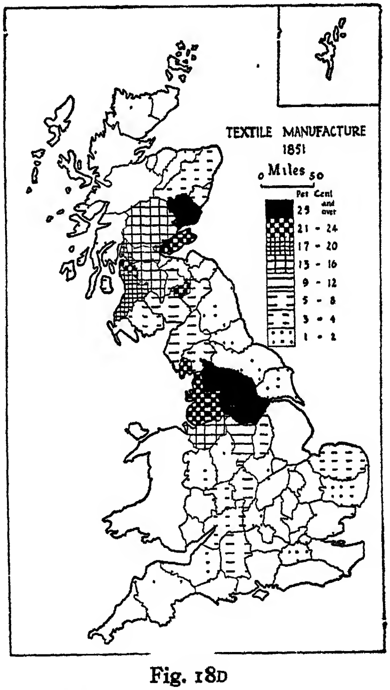


Fig. 18D

AGRICULTURE, TEXTILE MANUFACTURE, COAL MINING AND METAL WORKING IN 1851

per cent were engaged in agriculture or stock-keeping.[1] In the greater part of the country this formed the largest single occupational group, but in Lancashire there were more cotton workers than farmers and agricultural labourers, in the West Riding more woollen and worsted workers, in Durham (but not in Northumberland) more coal-miners, in Staffordshire more coal-miners and iron-workers. Large regional concentrations of population following single industrial occupations had thus clearly taken shape by 1851. This specialist regional industrialism was becoming increasingly urban: villages were growing into towns and towns into cities. The agglomeration of population was facilitated and the progress of this agglomeration accelerated by improvements in transport, both on land and on sea. They made possible the bulk import of food from abroad which a large industrial population divorced from the land required, and they made possible the bulk export of manufactures by which the industrial population lived.

IV

THE LATE NINETEENTH CENTURY

The middle of the nineteenth century marks an important stage in the modelling of the industrial geography of to-day. The mechanization of the processes of manufacture was not yet complete, mechanically created power was not yet the sole driving force of the industrial machine, and the factory system was not yet universal, but these changes were largely accomplished in the major *manufacturing* industries. It is true that the actual winning of coal—hewing at the coal face—was still a handicraft, and it remained so until the contemporary period: even in 1913 only 8·5 per cent of the coal output of Great Britain was cut by machine.[2] It is true that boot- and shoe-making was entirely by hand and only partly in factories, much still being done by out-workers on the domestic system, and it is true that there were yet no mechanical cutters nor sewing machines in the Leeds clothing trade. But the cotton industry was wholly mechanized, congregated into factories, and focused on Lancashire and the West of Scotland.[3] Worsted also was a machine factory industry, except for combing, but this too was largely mechanized by 1857.[4] The woollen industry, though largely mechanized, still had some hand-looms for another quarter of a century. By 1850 the worsted was concentrated into West Yorkshire and the

[1] Categories IX and X of Table VIII, less fishermen and plus cowkeepers of category XII (1).

[2] *Report of the Royal Commission on the Coal Industry*, vol. III (1925), Appendix no. 8, Table XXXI, p. 48.

[3] Of the 292,340 adults over twenty years returned as engaged in cotton manufacture in Great Britain in 1851, 176,155 were in Lancashire and 55,037 in the West of Scotland (*Census of 1851. Population Tables II*, vol. I (1854), Summary Tables, Tables XXVIII and XXIX).

[4] Clapham, *Free Trade and Steel*, pp. 30–2.

CHAPTER III

TRADE AND TRANSPORT

I

THE MIDDLE AGES

THE self-sufficiency of the Middle Ages, relative and not absolute though it may have been, implied a restricted volume of trade. It was at first in such articles as salt and iron, which were in general demand, but which not every locality could itself produce. Later, there arose a trade in corn and wool which, though produced in most parts of the country, were required at some points in quantities in excess of the local production. Parallel to this there developed a trade in finished manufactures, but it was not until towards the close of the Middle Ages that regional specialization in manufacturing production began to arise on any considerable scale. This was the internal trade. Foreign trade consisted of an export of corn and raw materials, such as wool and metals, and an import of wine, spices, and special manufactures. Though not negligible, trade was not as fundamental to the economy of the country as it is to-day. Its practice was not infrequently a part-time occupation, the cloth merchant, for example, being a cloth manufacturer as well, and it was largely carried on in periodic fairs and markets.[1] Transport was not dissimilar: it was irregular and spasmodic, it involved only small loads, and it frequently followed very circuitous routes.

The commodities involved in internal trade gradually increased in quantity and in range as local or regional self-sufficiency became modified and as the towns grew in size. The growth of the towns involved the development of a local trade in corn to feed the urban population which, from the twelfth century onwards, was devoting itself more and more to manufacture and was ceasing to grow sufficient corn for its own requirements. Trade in corn did not necessarily involve transport over more than a few miles, from the village to the local town, but to a minor extent there was also an inter-regional trade; for example, a coast trade from Lynn to Newcastle and a river trade from the upper Thames Valley to London.[2] Trade in wool also was considerable, not only the local trade from farm to town, but also an inter-regional trade, which was probably greater in wool than in corn and was faciliated by the relatively high value of wool

[1] 'They represent in fact a phase of commerce which can best be described as periodic' (Lipson, *Economic History of England*, vol. I, p. 221).

[2] N. S. B. Gras, *The Evolution of the Corn Market* (1926), pp. 35–64. The Oxford Clay Vale probably had an excess of production over local consumption requirements, London and Tyneside probably a deficit.

in proportion to its weight. Even in the Middle Ages the major clothing districts were probably not self-supporting in wool. They were certainly not self-supporting in later centuries. Traffic in heavy low-grade commodities was, however, very restricted in bulk and in range. Nef asserts that, except where river or coastwise navigation was available, coal was never transported more than a few miles from the point of mining.[1]

Trade was focused on periodic markets held once a week (or oftener) and fairs held once a year (or oftener). Markets were distributed quite thickly. It was laid down by a thirteenth-century lawyer that markets should be not less than 6⅔ miles apart, that is, one-third of a day's journey of 20 miles.[2] In Lancashire this was the approximate spacing, except in the hill districts of north and east, and except in the unreclaimed mosslands of the west, where they were spaced more widely apart, and except in certain well-drained parts of the plain, where they were congregated more closely together.[3] In East Anglia, with a medieval population greater than that of Lancashire, there were relatively more markets and an average spacing of 4 miles apart would probably be more correct. But here again markets were unevenly distributed.[4] Not all markets and not all boroughs had a gild merchant. Fig. 19, showing the distribution of gilds merchant from Gross's list,[5] might be expected to give some indication of the relative regional density of trading centres, though not necessarily of the relative regional volume of trade. It is, however, inexact even for this purpose for important trading towns, as London, Norwich, and the Cinque Ports have no records of having possessed a gild merchant. 'Indeed,' says Gross, 'we are struck with the prominence . . . of the Gild Merchant in many small boroughs. . . . The Gild Merchant did not necessarily imply considerable commercial prosperity or great industrial resources.'[6] The most important of the English fairs were Winchester, St. Ives, Stourbridge (near Cambridge), Bartholomew in London, Boston, Westminster, Northampton, and Bristol.[7] These were large general fairs and their sites lay significantly in the English Plain, half of

[1] Nef, *The Rise of the British Coal Industry*, vol. I, p. 8.

[2] Stenton quotes the daily itinerary of Robert of Nottingham on a journey from Nottingham to York and back to Lincoln in 1324–5 and the average daily ride works out at just over 20 miles, but this was a passenger journey and not the transport of goods. He also quotes a journey of twenty-one carts loaded with treasure from Westminster to Norwich in 1294; these averaged 12 miles a day (F. M. Stenton, 'The Road System of Medieval England', *Economic History Review*, vol. VII, no. 1 (1936), pp. 13–14 and 19).

[3] G. H. Tupling, 'Markets and Fairs in Medieval Lancashire', *Essays in Honour of James Tait*, Map opposite p. 346.

[4] R. E. Dickinson, 'The Distribution and Functions of the Smaller Urban Settlements of East Anglia', *Geography*, vol. XVII (1932), Fig. 2, p. 28.

[5] C. Gross, *The Gild Merchant*, vol. I (1890), pp. 9–18.

[6] Gross, op. cit., vol. I, pp. 90 and 92.

[7] Lipson, op. cit., pp. 229–32.

them in or close to the Oxford Clay Vale. There were many other smaller fairs, some of them for a particular commodity, such as the herring fair of Yarmouth or the cheese fair of Weyhill. At the close of the Middle Ages the annual or bi-annual fair was declining in relative importance, but it has even yet not died away. The decline of the fair in relative importance may be taken, however, to indicate the multiplication and regularization of trade, which itinerant merchants attending occasional fairs were no longer able to satisfy.

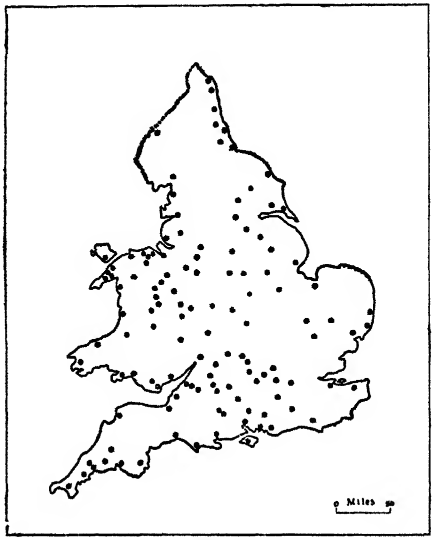


Fig. 19

BOROUGHS IN ENGLAND AND WALES WITH A GILD MERCHANT

Map drawn from list in C. Gross, *The Gild Merchant*, vol. I (1890).

The transport of goods was partly by river and coastal navigation and partly by road. Goods were carried by water wherever possible,[1] and the employment of the waterways was facilitated by the riverine and valley bottom distribution of the medieval population. The small boats then in use, large enough for the small unit cargoes requiring transport, permitted navigation far upstream and allowed a maximum navigable mileage. Even so late as the seventeenth century 'it would appear that boats on rivers, other than the Thames and Severn, had usually a burden of between 20 and 40 tons'.[2] It is probable that the medieval boat was smaller still. The rate payable for water-carriage was lower than for land-carriage—'about one-sixth', according to Thorold Rogers.[3] River transport was probably

[1] Stenton, op. cit., p. 19.
[2] T. S. Willan, *River Navigation in England, 1600–1750* (1936), p. 99.
[3] J. E. Thorold Rogers, *A History of Agriculture and Prices in England*, vol. I (1866), p. 663.

of more importance for heavy commodities than for passengers. For personal travel[1] it was slower to travel in a boat, unless wind and current were both favourable, than to ride on horseback, and Prof. Stenton's view is that for the passenger 'the waterways of England were never more than an occasional supplement to a road-system which on the whole was sufficient to his needs'.[2] Many transport routes, both for goods and for passengers, were composite, being in part by river and in part by road.[3]

The road plan involved in the aggregate a much greater mileage. It was a mosaic of long-distance routes, the straight Roman roads and the gently curving hill-top and hill-side trackways, and of local lanes, leading from village to common field and to common pasture. The Roman road system had not remained intact during the long centuries after the withdrawal of the Roman legionaries. Much of it stood in any case without repair, but where the road was carried over a stream it commonly tumbled down; where it passed through a stone-built country its shaped stones were frequently used for house or wall building; where it was adjacent to arable it was frequently broken up and ploughed. The Gough map of the early fourteenth century showed a plan, probably incomplete, of the major roads of the country, and, although it included stretches of Roman road, it did not consist entirely of them.[4] According to the road plan of the Gough map, London was the chief focus of the system, as it had been of the Roman roads and as it is of the railways to-day. But there were roads running athwart or at an angle to the pattern radial from London, and some regional centres, as Bristol, York, and Chester, had each their own radial road system. The dominance of London over other regional centres of English life was not yet complete.[5]

The medieval road, except the relics of the Roman system, had simply an earth surface, hard and dusty in summer, soft and miry in winter. It was understood in law not as limited between boundary walls or hedges, but as a right of way, and the medieval traveller had no hesitation, if the customary track were foundrous, in leaving it and riding on the stubble or common.[6] It is possible, as indeed it is likely owing to the difference in the condition of the road surface at the two seasons, that the cost of road carriage was higher in winter than in summer.[7] Road transport was by packhorse and by cart.

[1] Personal wayfaring was of considerable volume—the king and his court, the lord and his household, ecclesiastics, pilgrims, and merchants.

[2] Stenton, op. cit., p. 20.

[3] See examples given by R. A. Pelham, 'Fourteenth-Century England', *An Historical Geography of England before 1800*, ed. by H. C. Darby (1936), pp. 262–5.

[4] Stenton, op. cit., pp. 7–13. Also Pelham in *An Historical Geography of England*, p. 260.

[5] Stenton, op. cit., pp. 4–5.

[6] S. and B. Webb, *The Story of the King's Highway* (1913), pp. 5–7.

[7] Thorold Rogers (vol. 1, pp. 659–60) gives particulars of the cost of carriage of wine from which Jackman draws this inference, but the winter and summer journeys were not between the same places in each case and the assumption that there was everywhere the same mileage rate cannot be accepted.

Probably carts were used, except for carting between field and stack-yard, to a lesser extent than in later centuries when the road surface was cut up by wagon wheels into the condition described by Arthur Young. But perhaps Arthur Young had a higher standard than the medieval traveller of what a road should be. It is possible, as Pelham argues, that there was some regional differentiation between pack-horse and cart even in medieval times, the packhorse prevailing in rough hilly ground, the cart in the smoother country of the English Plain.[1] It fits in with what is known of later centuries and with what might be described as geographical probabilities.

The growth of internal and of foreign trade went on hand in hand. The commodities involved in foreign trade were chiefly wool and cloth, which were exported, and wine, which was imported. Of the trade handled by denizens[2] during the years 1446–8, out of a total export valued at £108,900 wool contributed £44,800 and cloth £60,100, and of a total import of £85,800, wine contributed £32,700.[3] The trade was a reciprocal one, the import being of commodities which England could not produce and the export being of commodities of which England produced an excess. These figures show a favourable balance of trade, which was true of that handled by aliens as well as by denizens; it was proper to a country in the stage of economic development in which England then was, but the favourable balance may have been due to political and not to economic causes.[4] During the early part of the Middle Ages the export of wool exceeded the export of cloth, but by the middle of the fifteenth century the export of cloth (reckoned in wool equivalents) had come to exceed the export of raw wool. By this time the customs accounts enumerated up to two dozen different varieties of English cloth and record the import, in small quantities, of dyes and of Spanish and German wool. During the early part of the Middle Ages the foreign trade of England was mainly in the hands of alien merchants and shipped in foreign bottoms, but by its close English merchants and English ships were handling the greater part of the foreign trade of the country.[5] The share of the wool trade handled by denizens increased from 35 per cent in 1273 to 75 per cent in 1333–6, 80 per cent in 1446–8, and 85 per cent in 1479–82.

By far the greater part of this foreign trade was handled by ports along the east and south coasts stretching from Hull to Bristol. These lay in and served the English Plain, the focus of medieval England. The ports of Wales and of North-west England were of but minor importance. The largest single port was London, not so clearly in the early part of the Middle Ages, but by the end of the

[1] Pelham in *An Historical Geography of England*, Maps 44–6.
[2] i.e. merchants of English nationality, the converse of aliens.
[3] H. L. Gray, 'English Foreign Trade, 1446–82', in Power and Postan, *Studies in English Trade in the Fifteenth Century* (1933), pp. 18–20.
[4] Gray, op. cit., pp. 20 and 37–8.
[5] N. S. B. Gras, *The Early English Customs System* (1918), p. 111.

fourteenth century its supremacy was clearly established. At the end of the thirteenth century London exported less raw wool than Boston,[1] and in the middle of the fourteenth century less cloth than either Bristol or Southampton;[2] but by the end of the fourteenth century and the beginning of the fifteenth century it was the premier port for the export of both raw wool and finished cloth. This growth was partly at the expense of other ports and bore witness to the development of the metropolitan at the expense of the local regional centres of English life. It was the east coast ports whose trade declined during the course of the fifteenth century: their decline was due partly to the competition of London, but also to the decline in the export of raw wool, one of their export staples. The western ports, in contrast, increased their trade, and in some respects the trade of Southampton and of Sandwich increased also.[3] The eastern and the western ports had each different overseas space-relations: the eastern were bound up with the North Sea and the Baltic, with Flanders and the Hanseatic League, while the western traded chiefly with Gascony, with Spain, and with the Mediterranean.[4] The increased trade of the western ports bore witness to the growing importance of the West Country within Britain, to their physical removal from London, and to the growing significance of the Atlantic frontage in Europe. The stage was set for the geographical discoveries of the fifteenth and sixteenth centuries.

II

THE SIXTEENTH AND SEVENTEENTH CENTURIES

By the end of the fifteenth century the localism of the Middle Ages was breaking down, a change expressed politically in the emergence of the Tudor nation-state and economically in the development of regional specialization of agricultural and industrial production, and, consequential upon this, in an increased volume of internal trade. In the phraseology of Prof. Gras, the metropolitan market was superseding the local market. Trade was still handled in part by periodic fairs and markets, but the growing bulk of trade was becoming too large to be limited to these periodic occasions. It came to acquire more regularized channels and the mercantile function became a full-time occupation. But, although the volume of trade increased, there was, prior to the Industrial Revolution, a

[1] R. A. Pelham, 'Medieval Foreign Trade: Eastern Ports', *An Historical Geography of England before 1800*, ed. by H. C. Darby (1936), Fig. 49.

[2] H. L. Gray, *English Historical Review*, vol xxxix, Appendix I.

[3] Tables of Enrolled Customs. Power and Postan, op. cit., pp. 330–60. These conclusions are drawn from a study of the average annual figures for each port for the decades 1408–18 and 1470–80.

[4] E. M. Carus-Wilson, 'The Overseas Trade of Bristol', Power and Postan, op. cit., pp. 183–246, and E. M. Carus-Wilson, *The Overseas Trade of Bristol in the later Middle Ages* (Bristol Record Society) (1936).

quickened flow of traffic to only a limited extent. River barge, small coaster, packhorse and wagon continued as previously to carry the goods traffic of the country. Speedier transport required better roads and improved waterways, and it required mechanical means of haulage. It had to await the Industrial Revolution.

The rivers continued to handle a substantial proportion of the goods traffic, for a boat could carry a greater quantity of goods than a packhorse or a wagon for a given amount of horse-power. A seventeenth-century writer estimated that a 30-ton boat could carry as much as 100 packhorses.[1] The waterways, however, did not appear to carry many passengers, and travellers mostly went by road. Leland, Celia Fiennes, Defoe, and Cobbett all took to the road and rode on horseback. Leland, in the early sixteenth century, listed bridges and ferries innumerable, but his interest was focused on means to cross a river and not on means to navigate it. Celia Fiennes, when in Bristol, noted 'Little boates w^ch^ are Call'd Wherryes such as we use on the Thames . . . to Convey persons from place to place', but this was purely local travel within the town.[2] The wherries plying on the Cam between Cambridge and Stourbridge Fair were similarly for local traffic.[3] The goods traffic on the rivers was chiefly of heavy low-grade commodities—coal, corn, timber, bricks—but was not confined to them, for there are records of wool, butter, bacon, wine, and cloth.[4] Concerning Leeds and Wakefield, Defoe wrote, 'I need not add, that by the same Navigation they receive all their heavy Goods, as well such as are Imported at Hull, as such as come from London, and such as other Counties supply, as Butter, Cheese, Lead, Iron, Salt; all sorts of Grocery . . . and every Sort of heavy or bulky Goods'.[5] Coal was shipped along the Severn from the Salop fields upstream to Shrewsbury and downstream to Gloucester and Bristol. It was distributed from the Port of London along the Thames upstream at least as far as Abingdon.[6] Celia Fiennes noted that the Thames between Oxford and Abingdon 'was full of Barges and Lighters'.[7] From Guildford, the head of navigation of the Wey, timber (brought on carts in summer from the Weald) and meal (ground in local river-side mills) were shipped downstream to London.[8]

These river barges were sailing vessels, and when the wind was light or in the wrong direction they were hauled by man or beast. Celia Fiennes saw on the Severn 'many Barges that were tow'd up by strength of men 6 or 8 at a tyme'.[9] Horses required towing paths to give them a foothold, but some Navigation Acts prohibited their

[1] F. Mathew, *A Mediterranean Passage by Water from London to Bristol* (1670). Quoted by T. S. Willan, *The English Coasting Trade, 1600–1750* (1938), p. 190.

[2] Fiennes, *Through England on a Side Saddle in the Time of William and Mary* (ed. of 1888), p. 200.

[3] Defoe, *Tour*, vol. I, p. 84.

[4] Willan, *River Navigation*, pp. 123–7.

[5] Defoe, op. cit., vol. II, p. 615.

[6] Willan, *River Navigation*, p. 125.

[7] Fiennes, op. cit., p. 29.

[8] Defoe, op. cit., vol. I, p. 145.

[9] Fiennes, op. cit., p. 196.

employment in order to meet the objections of river-side landowners. River transport, as in the Middle Ages, was cheaper than land transport. It was, at the dearest, about half the rate by road and, at the cheapest, was estimated at one-twelfth, but it varied greatly locally.[1] Freight rates were often greater upstream against the current than downstream with the current.[2]

The geographical distribution of this river trade was naturally dictated by topography. Dr. Willan has drawn maps of the distribution of navigable waterways in the seventeenth century and has marked on them those parts of the country more than 15 miles from a navigable river, a distance which represented approximately the average length of haul for timber by land possible in the course of a working day.[3] These maps show that the greater part of the English Plain, together with the Vale of York and the Midland Gate, was accessible to river transport. Navigation was interrupted, however, by many of the works of man. The water-wheel, in use in the Middle Ages, became widespread in the fifteenth century for fulling, corn-grinding, and forge-work, but subsequently for many other industrial uses. The overshot water-wheel was usually associated with a weir and a mill race, and these commonly obstructed the river and prevented navigation altogether. Leland reported of 'Foderingey' in Northamptonshire that Edward IV 'had thought to have privelegid it with a market, and with putting down weres and mills, to have causid that smaul lightters might cum thither'.[4]

During this period between the Middle Ages and the Industrial Revolution there were many schemes for river improvement. In the seventeenth century the Commissions of Sewers occasionally intervened to remove obstructions and so restore navigability, and in the late seventeenth and early eighteenth centuries Parliament passed some two dozen Acts to improve navigation on specified rivers. Of these Acts most referred to rivers within the English Plain, but by the end of the seventeenth century several northern rivers had become involved, and by the early eighteenth century more northern than southern rivers were affected. The rivers to which the Acts referred were mainly in one or other of the following regions: East Anglia, the lower Thames Valley, the West Country, the Black Country, the Vales of York and Trent, and the Lancashire–Cheshire Plain.[5] These were the industrial districts of the time and the

[1] Willan, *River Navigation*, pp. 119–21.

[2] W. T. Jackman, *The Development of Transportation in Modern England*, vol. 1 (1916), p. 208. An Act of 1774 authorized tolls on lime of $\frac{3}{4}d.$ upstream and $\frac{1}{2}d.$ downstream on the Aire and Calder. An Act of 1699 also for the Aire and Calder, fixed maximum tolls at 10*s*. in summer and 16*s*. in winter (J. Priestley, *Historical Account of the Navigable Rivers, Canals, and Railways of Great Britain* (1831)).

[3] See estimates of length of a day's journey in the Middle Ages, above.

[4] Leland, *Itinerary*, pt. 1, folio 4.

[5] The list is given by Willan, *River Navigation*, pp. 28–30. See also map on p. 90.

association of transport improvement with industry was not fortuitous.[1] The object of these schemes was to reduce traffic congestion: . . . 'it easeth,' said the Speaker of the House of Commons, 'the People of the great Charge of Land Carriages; preserves the Highways, which are daily worn out with Waggons carrying excessive Burdens'.[2] The river improvements which these Acts specified were the extension of navigability to rivers, or parts of rivers, not previously possessing it. Work was put in hand for the improvement of the Soar up to Leicester and of the Avon up to Coventry; in neither case had the river been navigable hitherto so far upstream.[3] But there were more far-reaching schemes than these. York took out an Act to straighten the meanders of the lower Ouse so that the Humber tide could reach the city's walls, and Chester experimented with the New Cut in the Dee estuary.[4] This was another kind of improvement, the digging of straight new channels, though these were still associated with existing waterways. They heralded the canal proper, dug independently of any river course. The lock, whereby a canal could surmount a gradient, was first used early in the seventeenth century on existing river navigations, but it did not become common until the canal era.[5] 'The invention of the pound-lock was almost as important as the discovery of steam-power. Without it the canal-building of the Industrial Revolution would have been impossible'.[6] These were the successive phases in what may be called the typology of river improvement.

The coasting trade was an important adjunct to the system of internal communications for the whole period prior to the railway era. Coal was carried in quantity coastwise, especially from the North-east coast to London, but the coastwise coal trade involved also the South Wales, the North Wales, and the West Cumberland fields.[7] Corn was shipped from east coast ports to London, and there was also a trade in wool, in butter and cheese, and in other farm produce. Nor was traffic limited to bulky commodities. Manufactures were transported as well in small parcels in the form of miscellaneous cargoes, and many of the exports from London, the first port of the realm, had first been collected by the coasting trade.

In the aggregate road traffic was almost certainly greater than river traffic and road mileage was, of course, very much greater than the mileage of navigable waterway. By far the greater number of passengers went by road, whether on horseback or by coach. Coaches were first employed about the middle of the sixteenth century,

[1] Jackman also remarks on the correlation.
[2] *Journal of the House of Lords*, XI, 675.
[3] Jackman, op. cit., vol. I, p. 181. [4] Jackman, op. cit., vol. I, pp. 197–206.
[5] Willan, *River Navigation*, pp. 88–94.
[6] Willan, *River Navigation*, p. 94.
[7] Willan, *Coasting Trade*, pp. 64–9.

apparently at first for town street work.[1] By the middle of the seventeenth century, stage-coaches were running from town to town on the main highways of the country. In 1658 stage-coaches were advertised to leave London on stated days for Exeter, a four-days' journey, for York, also a four-days' journey, for Newcastle, for Edinburgh, for Chester, and for Kendal, as well as intermediate destinations. These, however, ran on the average at no more than 30 miles per day, though greater distances were covered in summer, and their speed in miles per hour was very low.[2]

Goods traffic on the roads was by packhorse and by wagon. The packhorse was the earlier and more general mode of conveyance, and in hilly districts it was the only one. The single animal carrying farmers' produce or clothiers' pieces to market was supplemented by the train of packhorses, twenty or so in number, run by public carriers on stated routes and on stated days. Celia Fiennes remarked on the prevalence of packhorses and the relative absence of wagons in the hilly districts of the North of England, for example, near Kendal. In such districts horse panniers were employed not only for transporting relatively valuable commodities as raw wool or finished pieces, but also relatively bulky low-grade commodities: 'They also use horses on which they have a sort of Pannyers some Close, some open, that they strewe full of hay turff and Lime and Dung'.[3] In order to facilitate packhorse traffic narrow flagged causeways were frequently built, especially in hilly regions, and these were often raised above the general level of the road. Traces of these causeways remain to-day. High narrow bridges with a width sufficient only for the passage of one train of animals at a time and quite insufficient for the passage of a wagon, were built also primarily for packhorse traffic. Wagons were more common in the English Plain, with its lesser gradients. There had always been carts carrying between the field and the stack-yard, but wagons carrying goods for long distances gradually became more and more numerous during the last decades of the sixteenth, but particularly during the seventeenth and early eighteenth centuries, though until 1650 or thereabouts they were virtually confined to the main roads.[4] The wagon increased the weight of goods which a single animal could effectively move. Carriers' wagons, like carriers' packhorse trains, ran on regular routes and on stated days advertised beforehand.[5] In addition to packhorses and wagons, the roads were used by stock, being driven not only over short distances between farm and market within a region, but also from region to region, from Scotland to Norfolk, from Wales and the South-west Peninsula to London. It was a product partly of the growing urbanism of England, but more of

[1] Jackman, op. cit., vol. I, pp. 111–18.
[2] Jackman, op. cit., vol. I, p. 134.
[3] Fiennes, op. cit., p. 160.
[4] Webb, op. cit., p. 69.
[5] Jackman, op. cit., vol. I, pp. 122–3.

the needs of the New Husbandry for stock for winter feeding. Drove roads used by travelling stock were unusually wide, partly to facilitate movement, but also to provide some wayside grazing. Packhorse causeway and drove road each contributed a distinctive feature to the landscape and short stretches still remain here and there to-day.

The cost of road carriage was high, considerably more than the cost of water carriage. Jackman prints rates for Somerset, Lincoln, Derbyshire, and Northampton, which work out at 10*d.* to 1*s.* 3*d.* per ton per mile, the lower figure being frequently the summer rate and the higher the winter rate. These were for the late seventeenth and early eighteenth centuries.[1] All kinds of commodities were carried by road, but the high cost of transport implied that bulky low-grade commodities were carried for only short distances, long-distance traffic in these being possible only where river or coastal navigation was available. In that sense long-distance road traffic was selective and the packhorses and stage wagons working the long-distance routes carried mainly what the transport classifications would now describe as general merchandise.

This increasing volume of road traffic led to a deterioration in road surfaces. The endless procession of packhorses and of stock churned up the earth roads, muddy in winter and dusty in summer; and wagons, cutting deeply into the soft surfaces, wore deep ruts which further impeded traffic. Some Roman road surfaces were still used.[2] Only a small proportion of the road mileage of the country, however, was surfaced after the Roman fashion. The packhorse causeways eased the position to some extent, but many roads, even main roads, were almost impassable in winter.[3] The problem of road maintenance and improvement had become acute. The position was complicated by the character of the increased road traffic. The increase was not of local but of through traffic, the product of the regional agricultural and industrial specialization that was gradually taking shape in this period. 'On all the main lines of communication, what may be called the local use of the roads, by the farmers and cottagers who had to maintain them, became a steadily diminishing fraction of the total traffic.' The 'new users' of the road, in fact, were not those who were legally responsible for its maintenance, for the upkeep of the road was the responsibility of the local authority.[4] Road

[1] Jackman, op. cit., vol. 1, pp. 140–1.

[2] Leland, op. cit., pt. 1, folio 11. He reported of Weedon in Northamptonshire that it was 'a praty thorough fare . . . much celebratid by cariars bycause it stondith hard by the famose way . . . Watheling Strete.' (Leland, op. cit., pt 1, folios 42–6.) Elsewhere he wrote of 'the rigge' and 'the large high crest' of Watling Street, but whether as an antiquarian or as one interested in roads as a means of contemporary travel is not certain.

[3] Defoe records that the passage of geese from East Anglia to London was entirely an autumn traffic, partly because they could then feed on wayside stubbles 'as they go', but partly also because by the end of October the roads became 'too stiff and deep'. In his day geese had just begun to be carried in four-storied carts (Defoe, op. cit., vol. 1, p. 59).

[4] Webb, op. cit., pp. 14–18.

maintenance, however, even when performed as the law required, consisted merely in scouring the ditches, in keeping hedges cut closely to prevent overhanging branches shading the road, and in filling up the holes and ruts in the road surface with whatever stones or gravel were locally available.[1] No improvement in road surfaces was contemplated and, as wagons cut up the road, statutory limits were set to the number of horses which might be harnessed (which restricted the size of the wagon and therefore its capacity for damage), and later to the width of the wheel tyre.

The turnpike system arose to tackle this problem. It was but a piecemeal and local effort. An Act was taken out for a particular stretch of road by local men who formed themselves into a trust for the purpose. The Act empowered them to erect barriers at either end and to charge tolls from traffic passing through these barriers in order to accumulate funds for the improvement of the road surface. It was necessary to have Parliament's approval for this limitation of the freedom of the King's Highway. In 1663 Parliament authorized the erection of gates and the levying of tolls at three points on the Great North Road and the devotion of the moneys thus collected to road repair.[2] Before the end of the seventeenth century other roads were involved, all, except those of Cheshire, in the English Plain. This was still, economically, the most important region of the country. Most of them were along routes leading to London or else were in East Anglia or the West Country. But the chief spate of Acts setting up turnpike trusts was, significantly enough, after 1750, and it was not until the end of the eighteenth century that the more important roads of the country were continuously under turnpike administration.[3] The turnpike age did not begin in Scotland until after 1750. Jackman has classified road Acts subsequent to 1701 into regional groups. During the period 1701–50 road Acts were most numerous in the Home Counties and along the routes leading to London, in Yorkshire, Lancashire, and Cheshire, and in the West and East Midlands.[4] From this evidence it would appear that road Acts were becoming relatively more prominent in the rising industrial districts after 1700 than they had been before, though they were not yet as prominent as they were to become later. But, although so many roads had passed under turnpike administration, permanent improvement of their surface was not universal. Defoe expatiated on the benefits of turnpiking. Some improvement was unquestionably

[1] The village of Radwell in Hertfordshire complained of 'the nature of the soil being such as the winter devours whatsoever they are able to lay on in the summer'. Quoted by Webb, op. cit., p. 115.

[2] Wadesmill (Herts), Caxton (Cambs), Stilton (Hunts). In these cases the Justices were the authorities.

[3] Webb, op. cit., p. 125.

[4] Jackman, op. cit., vol. II, Appendix 13. His table relates to all road Acts and not only to turnpike Acts.

effected—roads were widened and graded and rivers bridged,[1] and, where these improvements were effective, travel was speeded and carriers' charges reduced. He admitted, however, that improvement was expensive and that where good hard material was not close at hand, as in stiff clay lands, no real improvement resulted.[2] In Bedfordshire the passage of fat bullocks to London 'often worked through in the Winter what the Commissioners have mended in the Summer'.[3] Permanent improvement had to await the road engineers, of whom Telford and Macadam were the chief. Their work was contemporary with the Industrial Revolution.

During this period, subsequent to the Middle Ages and prior to the Industrial Revolution, there was not only an increased volume of internal trade, but also an increased volume of overseas trade. It was part and parcel of the regional specialization of production within Britain and of an improving standard of living requiring products from overseas.[4] Sir William Petty, in the seventies of the seventeenth century, asserted in his *Political Arithmetick* that Britain possessed 'Two parts of Nine of the Trade of the whole Commercial World; and about Two parts in Seven of all the Shipping'.[5] Not only was the volume of trade greater than hitherto, but its geographical range was very much wider. During the Middle Ages British foreign trade had been limited to Europe and the Mediterranean, and it was focused chiefly on the nearby ports of the North Sea and the Atlantic coast. The geographical discoveries of the late fifteenth and sixteenth centuries threw open the whole world and British ships were to be found in every sea from Hudson's Bay to Nan Hai or the South China Sea. This widely flung trade was closely associated with the Colonial Empire which arose out of trade and which, indeed, itself stabilized it. During the Middle Ages there had been two companies—the Merchant Staplers and the Merchant Adventurers—engaged in foreign trade, but by the close of the sixteenth century six more companies had been added,[6] and it is significant that the new companies—the East India, the Eastland,[7] the Levant, for example—had each a regional rather than a general sphere of operations.

The largest single element in Britain's foreign trade was unquestionably woollen and worsted manufactures. Petty estimated these at £5·0 millions out of a total trade of £10·2 million (visible trade and shipping earnings),[8] but these figures cannot be regarded with

[1] Defoe, op. cit., vol. II, p. 525.
[2] Defoe, op. cit., vol. II, p. 522.
[3] Defoe, op. cit., vol. II, p. 523.
[4] '. . . we know that our own natural wares doe not yield us so much profit as our industry.' (T. Mun, *England's Treasure by Forraign Trade*. Reprint of ed. of 1664. (1933), p. 13).
[5] *The Economic Writings of Sir William Petty*, ed. by C. H. Hull, vol. I (1899), p. 297.
[6] E. Lipson, op. cit., vol. II (1931), p. 186.
[7] The Eastland claimed an antiquity greater than its charter of 1579. C. P. Lucas, *The Beginnings of English Overseas Enterprise* (1917), pp. 156–60.
[8] *The Economic Writings of Sir William Petty*, vol. I, p. 296.

any exactitude.[1] The export of lead, tin, and coal was estimated at £0·5 million and of Scottish and Irish produce at £1¼ million. Manufactures of wool, fish, and minerals were Britain's staple exports. Her imports were iron and flax to remedy the deficiencies of home production of industrial raw materials, special manufactures from abroad such as brassware and calico, and a variety of warm temperate and tropical produce—wines, oranges, spices, and sugar. Trade in corn was spasmodic and depended on the state of harvest: there was an export in times of plenty, import in years of low yield. The commodities[2] involved in this foreign trade issued out of the geographical constitution of the country and of the stage in economic development which it had then reached.

By the close of the Middle Ages London had come to be indisputably the chief port of the kingdom and had grown at the expense of other ports of the east coast. According to the table of customs dues constructed by Gras for 1536–1711, London collected between 72 and 87 per cent of the entire customs revenue of the country.[3] London was to England what Paris and Rouen together were to France, 'Rouen being to Paris as that part of London which is below the Bridge, is to what is above it'.[4] London was the natural focal point of the English Plain, and, so long as the English Plain was the heart of English life and economic activity, London was the focal point of England. Its importance as a trading centre had grown in the later Middle Ages with the modification of medieval localism, and it grew, relative to the country as a whole, still more with the emergence of the nation-state during the sixteenth century. Its commercial pre-eminence was not infringed until the Industrial Revolution modified the balance of regional economy within Britain. In 1700 London handled 80 per cent of the imports of the country and 74 per cent of the exports, but in 1750 71 per cent of the imports and 66 per cent of the exports, and in 1790 70 per cent of the imports and 56 per cent of the exports.[5] Even in the early eighteenth century

[1] The import and export values in a long series of returns from 1696 to 1853 are of little use as they stand, for the values were official and not real values. In 1853 *official* values showed an excess of exports over imports; in 1854 *real* values showed an excess of imports over exports. The returns of quantities at present remain in MSS. See G. N. Clark, *Guide to English Commercial Statistics, 1696–1782* (1938).

[2] For lists of commodities to particular markets, see an account of the late sixteenth century printed by Gras, *Corn Market*, Appendix J; and for the middle of the seventeenth century a list drawn up by M. P. Ashley and printed by J. N. L. Baker, 'England in the Seventeenth Century', *An Historical Geography of England before 1800*, ed. by H. C. Darby (1936), pp. 431–2. Expansion of trade with the tropics proved difficult for Britain had little to send except woollen cloth, an unsuitable clothing material in a hot climate.

[3] Gras, *Corn Market*, p. 74.

[4] *The Economic Writings of Sir William Petty*, vol. II, p. 539.

[5] Quoted by O. H. K. Spate, 'The Growth of London', *An Historical Geography of England before 1800*, ed. by H. C. Darby (1936), p. 543. It is not clear whether 'the country' is England alone or Great Britain.

there were proceeding changes in the regional balance of the British economy, and it is noticeable that then, as now, London handled a greater share of the imports than of the exports. The predominance of London in foreign trade, though based fundamentally on the focal position of London within the English Plain so long as the English Plain remained the heart of English economic life, was heightened by the monopolist organization of foreign trade. The corporate companies were organized from London and their members were largely London merchants.[1]

The importance of London in foreign trade did not imply the stagnation of shipping and trade in the innumerable ports of the estuaries and creeks of the British coastline. They could be the more easily used by reason of the small burden of the sea-going ships of the day.[2] A list of ports in the reign of James I gives a total of 194 for Great Britain and Ireland.[3] A list drawn up in 1578 by an Admiralty official gives 391 for England and Wales alone, but a great number were mere creeks and landing-places.[4] Whatever the volume of foreign trade at these ports, there was an increasing volume of coastwise trade which contributed in part, of course, to the foreign trade of London. The accounts of ports visited by both Celia Fiennes and Defoe give the impression of a busy thriving trade, and the latter recognized that each port engaged in foreign trade had some regional speciality of its own. Yarmouth brought in naval stores from Norway and the Baltic, and sent to the Mediterranean herrings and worsted; Hull traded with Northern Europe and the Mediterranean, but 'the Trade of Tobacco and Sugars from the West-Indies, they chiefly manage by the Way of London';[5] Newcastle was not mentioned as having any foreign trade at all. It is clear, however, that these east coast ports engaged in little *direct* foreign trade beyond Europe. Of Bristol, Defoe writes significantly, 'the greatest, the richest, and the best Port of Trade in Great Britain, London only excepted. The Merchants of this City not only have the greatest Trade but they trade with a more entire Independency upon London, than any other town in Britain.' Bristol, together with Exeter, Liverpool, and Glasgow,

[1] But the Merchant Adventurers, for example, were not confined to London; there were branches at York, Hull, Newcastle, Lynn, Norwich, Ipswich, Exeter, and Southampton, *inter alia*. These branches struggled for independence inside the Company just as the interlopers, with their demand for free trade, did outside the Company. It is not without significance that it is mainly the east coast ports that are represented in this list. See also the discussion of this point by Lucas, op. cit., Chapter III.

[2] V. Barbour, 'Dutch and English Merchant Shipping in the Seventeenth Century', *Economic History Review*, vol. II, no. 2 (1930), pp. 262–3. The greater part consisted of vessels of less than 100 tons. Larger ships were built for the East.

[3] R. G. Marsden, 'English Ships in the Reign of James I', *Transactions Royal Historical Society*, vol. XIX (1905), pp. 336–7.

[4] D. and G. Mathew, 'Iron Furnaces in South-eastern England and English Ports and Landing Places, 1578', *English Historical Review*, vol XLVIII (1933), pp. 96–9.

[5] Defoe, op. cit., vol. II, p. 652.

other west coast ports, traded with the Americas and (Bristol and Liverpool only) with Africa independently of London.[1] Situated in the more remote west of Britain and their own space-relations naturally favouring the Atlantic trade, they were the more able to combat London's dominance. They had each also local industrial resources and a substantial local market for imported overseas produce. Even in the later Middle Ages the trade of these western ports was increasing while that of the eastern ports (apart from London) was declining. London's undisputed supremacy was limited to the English Plain and to the east coast, that part of Britain for which it was the natural focus and centre.

III

THE REVOLUTION IN TRANSPORT

With the development of commercial production in farming and in industry during the sixteenth and seventeenth centuries, the volume of trade had been steadily increasing; but with the Agrarian and Industrial Revolutions and with the arrival of commercial production and of regional specialization in full stature, the volume of trade grew by leaps and bounds. By the end of the eighteenth century, if not previously, Britain had become to the continental mind a nation of shopkeepers. The existing system of transport was inadequate to carry the swollen volume of goods and, if the economic development of Britain was to proceed, improvement in the means and acceleration in the speed of transport was essential. There was a revolution in transport equally with a revolution in agriculture and industry.

The turnpiking of roads had begun even before the eighteenth century, but the real spate followed the middle of the century. According to Jackman's calculations, there was an annual average of eight road Acts during the years 1701–50, of forty-one during the years 1751–90, and of sixty-one during the years 1791–1830. Table XVIII summarizes the regional distribution of these road Acts, which included turnpike Acts among others. Relative to their area, the Home Counties especially, but also the West and East Midlands, the lower Severn Valley, and the West Country had above their share; the northern counties, the South-west Peninsula, East Anglia, and Lincoln, had under their share; Yorkshire, Lancashire, Cheshire, had Acts more or less proportional to their area. Expressed in general terms, therefore, it was the Home Counties and the industrial districts that had the greatest number of road Acts and the agricultural districts that had the least. The Home Counties had a high proportion because of 'suburban' traffic and because the road plan of England was focused on the metropolitan centre; the industrial districts had a high proportion because of the needs of industrial traffic within

[1] For Exeter, see W. G. Hoskins, *Industry, Trade, and People in Exeter, 1688–1800* (1935), p. 63; for Liverpool, *Social Survey of Merseyside*, vol. 1 (1932), pp. 15–16.

TABLE XVIII

Regional Distribution in England of Road Acts, 1701–1830, and of Turnpike Mileage, 1829

	Percentage of Road Acts			Percentage of area	Percentage of turnpike mileage 1829
	1701–50	1751–90	1791–1830		
Northumberland, Durham, Cumberland, Westmorland	3·8	4·8	5·6	10·5	7·3
Yorks, Lancs, Cheshire .	17·2	13·7	19·6	17·4	13·3
Derby, Staffs, Notts, Salop, Warwick, Leics, Rutland, Northants . . .	13·2	23·2	21·1	14·3	20·8
Hereford, Worcester, Monmouth	4·8	5·0	4·1	4·2	7·8
Berks, Oxon, Bucks, Beds, Herts	21·3	10·2	8 6	6·6	6·8
Lincs, Hunts, Cambs, Norfolk, Suffolk, Essex . .	10·5	8·0	8·3	17·6	9·6
Middlesex, Kent, Hants, Surrey, Sussex . . .	19 6	17·4	17·0	11·2	13·5
Gloucester, Wilts, Somerset .	9 6	11·6	10·2	8·4	12·9
Dorset, Devon, Cornwall .	—	6·1	5·5	9·8	8·0
England	100·0	100·0	100·0	100 0	100·0
No. of Road Acts . .	418	1,633	2,440		

Particulars of Road Acts from W. T. Jackman, *The Development of Transportation in Modern England* (1916), vol. II, Appendix 13. Particulars of turnpike mileage calculated from G. R. Porter, *The Progress of the Nation* (1847), p. 294.

them and between manufacturing district and port. The Home Counties had their largest share early in the eighteenth century, 40·9 per cent of the Acts (1701–50) in 17·8 per cent of the area; they were the first to be involved on a large scale. The West and East Midlands, on the other hand, had a much greater proportion of Acts after 1750 than before that date. Turnpike mileage in 1829, the result of over a century of activity, was greatest in the Home Counties, the West and East Midlands, the West Country, and the lower Severn Valley; and least, relative to area, in northern England, in eastern England, and in the South-west Peninsula.

Improvement in road surfaces lagged behind the creation of turnpike trusts. There was some improvement in Defoe's day and more after 1750, but it was not until after 1800 that *permanent* improvement was really effected. The half-century, 1750–1800, was a period when experiments in road construction and road surfacing —something beyond the mere filling up of ruts and holes—were beginning to be made. The two great masters were Thomas Telford and John Macadam, but it was not until the last decades of the

eighteenth century that they began their work.[1] Telford was commissioned to reconstruct the Carlisle–Glasgow road, the Edinburgh–Morpeth road, and the London–Holyhead road. These were large-scale objectives, and the Post Office, anxious to accelerate the carriage of mails, encouraged them and, in the case of the Holyhead road, initiated the scheme. The Holyhead road took fifteen years to reconstruct, and it was to have been followed by a remodelled Great North Road along the eastern side of England, including a straight hundred miles from Peterborough to York. The project, however, was abandoned after the Rainhill locomotive trials and the dawn of the railway age. The railway was a more effective means of national communication than the road, however well constructed the latter might be. The work of Macadam was being accomplished contemporaneously with that of Telford, but rather in respect of regional road systems, the roads around Bristol and then the roads around London, than of long-distance inter-regional routes. The local roads, apart from those near the great towns, exhibited much less improvement until later on in the nineteenth century. With the railway age and the virtual monopoly of through communication by the railway, the administration of the roads reverted to the local authority and one by one the turnpike trusts disappeared as they came before Parliament for renewal. The toll-bars had become a public nuisance and a restraint to trade. In 1871 854 trusts remained, but in 1881 only 184, and the last, in Anglesey, came to an end in 1895.[2] The surfacing of secondary as well as of primary roads was gradually improved, but, being now concerned chiefly with local traffic, little grading and little straightening of sharp curves and bends was accomplished.

The improvement of road surfaces increased the speed of travel. Jackman's general conclusion is that by 1830 the fast mail and passenger coaches had an average speed of 9–10 miles per hour, about double what it had been prior to 1750.[3] The London to Manchester journey had taken 4½ days in 1754, but by 1830 it was reduced to 20 hours.[4] Increased speed of travel, together with the growing specialization of production, multiplied the volume of passenger travel. In 1801 seven coaches left Chester daily, but in 1831 twenty-six. Wagons carrying goods travelled, of course, much more slowly. Even the 'fly wagons' went at only 2½ miles per hour on the average. It is probable that road-rates for goods had changed but little. There was, of course, wide variation, but they lay mostly between limits of 10*d.* and 1*s.* 3*d.* per ton-mile, the same as for the late seventeenth and early eighteenth centuries.[5] Road

[1] For the principles on which each worked, see Webb, op. cit., Chapter VIII and Jackman, op. cit., Chapter IV.

[2] Webb, op. cit., p. 222.

[3] Jackman, op. cit., vol. I, p. 339.

[4] Jackman, op. cit., vol. II, Appendix 5.

[5] Jackman, op. cit., vol. I, pp. 346–8, and vol. II, Appendix 7.

improvement had not solved, though it had eased, the transport problem, for the carriage of goods on land was still extraordinarily expensive.

Contemporary with the reconstruction of the roads was the digging of canals. The period 1750–1830 may be termed the road and canal era as distinct from the railway era which was to follow it. The antecedents of the canal in the deepening of rivers and later in the digging of cuts to eliminate circuitous meanders have already been considered. The next stage in the evolution of the canal was the digging of a channel parallel to the existing river or brook and the feeding of the canal channel by river water, as, for example, the Douglas Navigation of 1720 and the Sankey Canal of 1755. This was comparable to the *canal latéral* of the Paris Basin. The first canal dug independently of any river course was the Worsley, a 10-mile channel from Worsley to Manchester, opened in 1761. It presented considerable engineering difficulties, for it was a completely 'level' or contour canal constructed over undulating country, and it involved the construction of the famous Barton viaduct over the River Irwell. It halved the price of coal in Manchester. It was followed by the Bridgewater Canal from Manchester to Runcorn, parallel to the pre-existing Mersey and Irwell Navigation, and completed in 1767. This also was a contour canal without locks, but, as the outfall of the Mersey into its estuary at Runcorn was considerably lower than the river at Manchester, the terminus of the canal at Runcorn was some 79 feet above the estuary. An imposing flight of locks was later built to negotiate this gradient and to link the canal with the estuary. The canal was an immediate success, both for passengers and for goods. The Manchester to Liverpool journey for passengers was by canal packet from Manchester to Warrington and then by coach from Warrington to Liverpool. The canal packet did the round trip, Manchester to Warrington and back, in a day. Though it took longer, the whole journey from Manchester to Liverpool was sometimes done by boat. It will be noticed that these early canals were in South Lancashire and were closely associated with the manufacturing town of Manchester and its links with the port of Liverpool.[1] This was one of the most rapidly developing industrial districts of the period; moreover, its fustian and cotton manufacturers imported almost all their raw materials and exported a not inconsiderable proportion of their finished production. Transport improvement began where need was greatest. The Bridgewater Canal was followed by the Grand Trunk or Trent and Mersey, whose

[1] The need for improving communication between Manchester and Hull for Lancashire's Baltic trade during the French wars was responsible for the Rochdale Canal across the Pennines. Previously Manchester goods were carried on wagons over difficult country to wharves at Huddersfield, Sowerby Bridge, or Salterhebble (A. Redford, *Manchester Merchants and Foreign Trade, 1794–1858* (1934), pp. 169–177).

name described its objectives, by the Staffordshire and Worcestershire, by the Coventry, by the Oxford, and by a whole series of canals in the West Midlands, in Lancashire, and in West Yorkshire. The period of greatest activity in the taking out of canal Acts was that of the decades 1791–1810: it included the 'canal mania' of 1792–3. The annual average for 1751–70 was 1·2, for 1771–90 2·3, for 1791–1810 10·8, and for 1811–30 5·4.[1] There was, of course, a time-lag of several years between the taking out of an Act and the completion of the canal ready for operation. It would, however, appear that the spate of canal building had begun to slacken before the locomotive railway was a proved success.

TABLE XIX

Regional Distribution of Canal Acts in England, 1751–1830

	Percentage of Canal Acts				Percentage of Area
	1751–70	1771–90	1791–1810	1811–30	
Northumberland, Durham, Cumberland, Westmorland	—	—	1·9	1·0	10·5
Yorks, Lancs, Cheshire	29·1	23·8	22·3	12·0	17·4
Derby, Staffs, Notts, Salop, Warwick, Leics, Rutland, Northants	50·0	47·8	29·3	24·1	14·3
Hereford, Monmouth, Worcester	12·5	8·7	7·0	6·5	4·2
Berks, Oxon, Bucks, Beds, Herts	4·2	2·2	6·5	7·4	6·6
Lincs, Hunts, Cambs, Norfolk, Suffolk, Essex	4·2	2·2	6·0	6·5	17·6
Middlesex, Kent, Surrey, Sussex, Hants	—	6·5	7·9	22·2	11·2
Gloucester, Wilts, Somerset	—	4·4	14·9	15·7	8·4
Dorset, Devon, Cornwall	—	4·4	4 2	4·6	9·8
	100·0	100 0	100 0	100·0	100·0
No. of Canal Acts	24	46	215	108	

Particulars calculated from W. T. Jackman, *The Development of Transportation in Modern England*, vol. II, Appendix 13.

Jackman has made a regional grouping of these canal Acts and Table XIX has been calculated from his figures. The chief areas of concentration were Lancashire and Yorkshire, the West and the East Midlands: together they had 202 out of a total of 393 Acts, or 51·4 per cent, and in the earlier years before the 'canal mania' they had 52 out of 70, or 74·3 per cent. These were the rising industrial districts where the transport problem was most acute. The South of England, becoming increasingly agricultural, had few canals until

[1] Jackman, op. cit., vol. II, Appendix 13.

the latter part of the canal era, and many were constructed during the Revolutionary and Napoleonic Wars with the strategic design of linking the Bristol Channel with the Thames Estuary and avoiding the dangerous passage of the English Channel. Apart from this, canals in the South of England were the result of transport imitation rather than of transport need. The North-east coalfield had no canals and the South Wales coalfield few; the mineral tramway was here the chief means of internal transport. Though there have been some additions and many subtractions (owing to canals becoming derelict), the present-day plan described in a later chapter is in general terms the same as that existing in the early nineteenth century.

The canal was, above all, an industrial form of transport. Of the total revenue earned by the Bridgewater Canal in 1792, passengers accounted for only 1·8 per cent.[1] There were passenger canal packets, but they went at a lower speed than the 9–10 miles per hour of the stage-coaches. The speed of freight barges on the canals was little different from that of goods wagons on the roads: the 'fly boats' went at $3\frac{1}{2}$ miles per hour and the slow traffic at 2 miles per hour, but the average speed was probably less owing to delays at locks. The road and the canal, with similar speeds of transit, shared the goods traffic between them.

The largest single item in goods traffic on the canals was unquestionably coal. They were the true heirs of the rivers in that they carried the bulky produce of the country. The carriage of coal was the *raison d'être* of the Worsley Canal, and coal figured in nearly every canal prospectus, as, prospectively, the most important revenue-earning commodity. This was true of canals even in agricultural districts, and the promoters of at least one canal advanced the philanthropic motive that coal would make better fires in the labourer's cottage than what firing he had hitherto been able to pick up from the fields and hedgerows. But the dominance of coal was especially true of canals in the industrial districts. Coal was the life blood of the new industrialism and long lines of factories and mills were built along the canal banks in order to facilitate receipt of coal as well as of other materials. A canal site was of immense importance in the detailed localization of industrial premises in every industrial district of Britain, the ports included. The industrial districts required coal not only for industry, but also for domestic consumption, a substantial market with the growing aggregation of population into towns. Coal traffic on the canals, however, was short-distance rather than long-distance. It is true that canal-borne coal had invaded the market formerly supplied by coal brought coastwise from the North-east coast, but this was coal from the York–Derby-

[1] Jackman, op. cit., vol. 1, p. 363.

Nottingham field close at hand,[1] and London received only a fluctuating and minor proportion of its coal supply by canal, in the 'thirties varying from 1,004 to 10,742 tons annually out of a total London consumption of 1,500,000 tons annually.[2] In 1836 Manchester obtained 570,628 tons by canal from little more than 15 miles radius and 316,258 tons by road from shorter distances, chiefly the Pendleton and Oldham roads. In the same year the Liverpool and Manchester Railway brought in only 27,105 tons. Liverpool, farther removed from the coalfield, obtained more by canal and less by road —in 1844, 875,000 and 20,000 tons respectively.[3] The very local traffic was thus partly in the hands of the road carriers.

The long-distance traffic was in general merchandise rather than in coal. London was the chief importing port, and 'raw materials as wool, tin, and cotton were regularly shipped to the manufacturing Midlands and the North along the Grand Junction Canal'.[4] Before the construction of the Liverpool and Manchester Railway, Manchester drew in imported supplies from Liverpool by the Bridgewater Canal. General merchandise usually paid higher freight rates than bulky low-grade commodities such as coal, but general merchandise travelled longer distances because, being more valuable, it could bear more easily the cost of transport. An account of the cost of carriage by canal gave $2\frac{3}{4}d.$ per ton per mile for heavy goods and $3\frac{3}{4}d.$ for lighter goods.[5] The lower charges by canal than by road amounted to a substantial saving on the long-distance routes, the rate from Liverpool to Birmingham, for example, being 30*s.* per ton by canal, but 100*s.* by road.[6] Wherever possible, therefore, the canal was used for long-distance traffic unless quick transport was essential. Although cheaper than road transport,[7] canal transport was little different in cost from river transport prior to the Industrial Revolution. Neither turnpike road nor canal effected any substantial reduction of transport costs, taking the country as a whole. They may have increased the speed of transport and the mileage open to traffic, and so increased the effective quantity of goods which could be transported, but they had not solved the transport problem. Moreover, the volume of goods requiring transport continued to increase, and there was still danger of the existing means of transport becoming choked. The stage was set for the advent of the railway.

The precursor of the railway had been the wagon tramway, nearly always a mineral line. This dated back to the mid-seventeenth

[1] *Report and Minutes of Evidence*, Lords' Committee on Coal Trade (1830), p. 59.

[2] *Report*, Royal Commission on Coal (1871), vol. III, p. 45.

[3] *Report*, Royal Commission on Coal (1871), vol. III, Appendix LV and p. 53.

[4] Clapham, *Early Railway Age*, p. 79.

[5] Jackman, op. cit., vol. I, p. 449.

[6] Jackman, op. cit., vol. I, p. 447.

[7] Canal rates were at least one-half and usually one-third or one-fourth road rates for the same class of commodity.

century and during the eighteenth century it had become common in many British coalfields—the North-east Coast, South Wales, South Lancashire, Salop, the Yorkshire–Derby–Nottingham, and Scotland, but especially the two former, where tramways connected the coal-pits by a down gradient to the coal staithes on the rivers or the coast. In the inland fields tramways usually led to a canal or river wharf, and the canal companies welcomed their construction accordingly. Indeed, some canal companies themselves constructed branch railways in lieu of branch canals.[1] At first tramway rails and wagon wheels were of wood, but in time the wooden rail was given an iron surface plate, iron wheels were substituted for wooden wheels, and then iron rails for iron-plated wooden rails. Thus the *railway* replaced the *plateway*. One of the early experiments in making iron rails was at the Coalbrookdale Ironworks, where the coke iron industry had been born. Wherever possible it was arranged that full trucks should have a down gradient and move by gravity, but in the opposite direction horse haulage was necessary.

There were several experiments in the last quarter of the eighteenth century in the application of the Boulton and Watt steam-engine to mechanical traction, on the roads and on the railways. Trevithick's engine was employed in South Wales in 1804 and Hedley's and Stephenson's engines were at work in 1813 and 1814 respectively; in each case these ran on private mineral lines. The first public railway with a locomotive engine was the Stockton and Darlington, constructed in that region of the country where the wagon tramway was the established means of transport. It was opened in 1825, and the company at first undertook only goods haulage by locomotives. Private coach proprietors were allowed, after paying tolls, to run passenger coaches on the rails and to draw their coaches by horses.[2] The organization of carriage on the railway was then considered in the same light as the organization of carriage on the road and on the canal. Speeds were low and there was little traffic congestion at first. On some of the early railways steep gradients were surmounted by the use of stationary engines. The Liverpool and Manchester Railway was opened in 1830 and its prospectus contemplated a substantial passenger as well as goods traffic. The promoters were not disappointed. From the first it ran six passenger trains a day in each direction,[3] and in the first two years carried approximately 1,200 passengers daily.[4] It served a district where the need for transport

[1] Priestley (op. cit., p. 31) gives an example from the Ashby-de-la-Zouch Canal.

[2] There was a curious but interesting revival of this in a *Memorandum on the Light Railway Requirements of Rural Districts* drawn up by the Royal Agricultural Society in 1895, in which the suggestion was made that farmers should be permitted to haul on such light railways their own wagons if filled with farm produce or goods destined for farm consumption.

[3] H. G. Lewin, *The British Railway System* (1914), p. 12.

[4] In the first two quarters of 1831 receipts were £436,000 from passengers and £22,093 from goods (Jackman, op. cit., vol. II, p. 528).

improvement was urgent, almost desperate. It was the first *complete* railway in the sense that it was worked by locomotive engines and served all the functions of a common carrier.[1] The success of this railway was the cause of a spate of railway promotion and construction during the 'thirties, and by 1840 most of these lines were in operation. Bradshaw's railway time-table first appeared in 1839. The railway age had begun.

Fig. 20 has been drawn to show the development of the system at sample dates.[2] Railways initially independent and initially constructed to serve local needs gradually reached towards each other and coalesced into a national system. Local regional networks and inter-regional links were constructed concurrently, the latter becoming the main-line systems. It was to serve the manufacturing districts and the metropolis that railways were first built. C. E. R. Sherrington stresses the point that it was the manufacturing districts which were the chief pivot of early railway enterprise, and that London played little part at first. 'Railways tended to stretch towards London, rather than from London',[3] and there was no inter-connexion of London railway terminals. Many North of England towns had in later years, and still have, the same absence of terminal inter-connexions.

The railway almost immediately revolutionized the transport situation. The Liverpool and Manchester Railway carried passengers for half the rate of the coaches[4] and goods for one-third the rate of the canals. The cost both of passenger travel and of goods traffic was substantially reduced, and the greater speed of the railway locomotive allowed the effective carrying capacity of the railway, as compared with road or canal over the same mileage, to be greatly increased. The transport problem was, for the time being, in process of solution. Almost immediately the railway monopolized passenger traffic along its route and its cheaper fares stimulated travel. Stage-coaches and canal packets soon ceased to run. There had been commercial travellers even in the road and canal era, but they increased greatly in number in the railway age. The seaside resorts began to develop[5] with railway access, and, though their clientele was at first small, it grew steadily with increased ease of access and an improving standard of living. In 1845 the railways as a whole made 64 per cent of their gross receipts from passengers, though the

[1] G. S. Veitch, *The Struggle for the Liverpool and Manchester Railway* (1930), pp. 19–20. The Stockton and Darlington did not immediately assume *all* the functions of the common carrier.

[2] The maps have been constructed by Miss M. Salmon, to whom I am indebted for permission to include them here.

[3] C. E. R. Sherrington, *Economics of Rail Transport in Great Britain*, vol. I (1928), p. 28.

[4] The single fare from Liverpool to Manchester was 7*s*. first class and 4*s*. second class (Print in Veitch, op. cit., opposite p. 47).

[5] E. W. Gilbert, 'The Growth of Inland and Seaside Health Resorts in England', *Scottish Geographical Magazine*, vol. LV (1939).

proportion fell in later years. The proportion received from passengers was greatest in rural agricultural areas and on the lines leading to and from London: the Eastern Counties Railway drew 90 per cent of its revenue from passengers and the London and Birmingham Railway drew over 75 per cent. In the manufacturing districts the proportions were more nearly equal, though passengers were usually the more important. In the mining districts alone was passenger traffic the minor element in railway revenue.

But the goods traffic did not pass over to the railways so completely. In the 'forties the Bridgewater Canal and the Mersey and Irwell Navigation combined were carrying over double the tonnage carried by the Liverpool and Manchester Railway.[1] The Grand Junction Canal increased its traffics between 1833 and 1852.[2] But these were well-managed concerns, and they had few locks and a minimum of traffic delay. In order to retain their traffic, however, they were compelled to reduce their rates, the reduction amounting usually from one-third to one-half.[3] The factories and mills located on the canal side would naturally continue to use the canal, for the local haulage rate from station terminal to factory yard would thereby be avoided. Of the goods traffic, it was general merchandise that the railways acquired most easily. Even so late as 1865 the railways of agricultural South-east England carried three times as much general merchandise as minerals.[4] The railways serving the coalfields, however, had all a heavy minerals traffic. The relative proportion of minerals even on the railways of South-east England gradually increased, and by 1900 these railways were handling a greater tonnage of minerals than of general merchandise. The canal, however, clearly retained for a long time much of the traffic in heavy low-grade commodities. Nevertheless, the canal, taking the country as a whole, had become subordinate to the railway. Many canals were bought up by the railway companies either as part of a conscious policy to buy out competitors or because the canal companies, as vested interests, obliged Parliament to force the railways to buy them or lease them in order to ensure that their shareholders should suffer no loss. In any case, the canals would have fallen behind the railways as the most important means of communication. They were slow; they were cumbersome; they were soon choked with traffic; and they belonged altogether to a more leisurely age than that of the new industrialism. Few canals were able to effect improvements in order to meet the new situation, for they could attract no new capital,

[1] In 1840–8 the waterways carried 2,236,198 tons and the Liverpool and Manchester Railway 981,681 tons. Jackman, op. cit., vol. II, Appendix 12. These are tonnages and not ton-mileages.

[2] Jackman, op. cit., vol. II, p. 739. Increase was chiefly in local traffic, but there was also increase in through traffic.

[3] Jackman, op. cit., vol. II, Appendix 10.

[4] Sherrington, op. cit., vol. I, Table I.

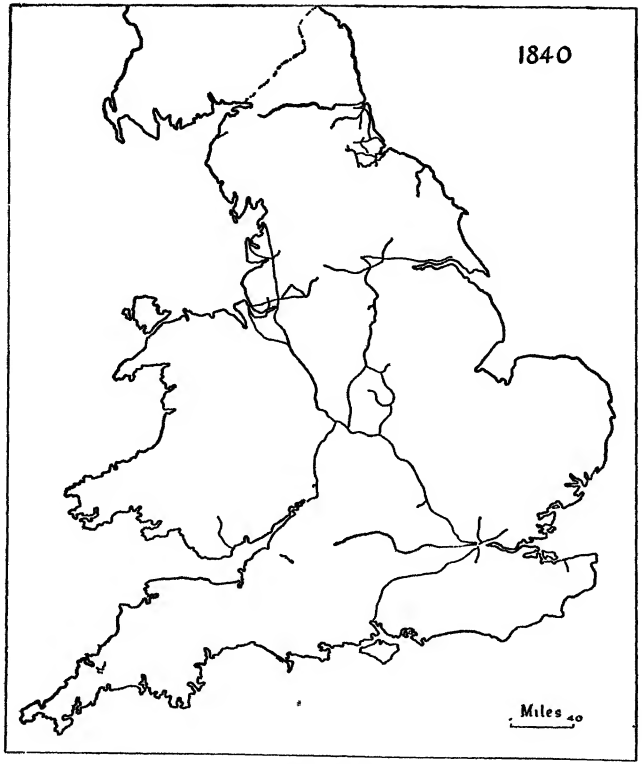


Fig. 20A

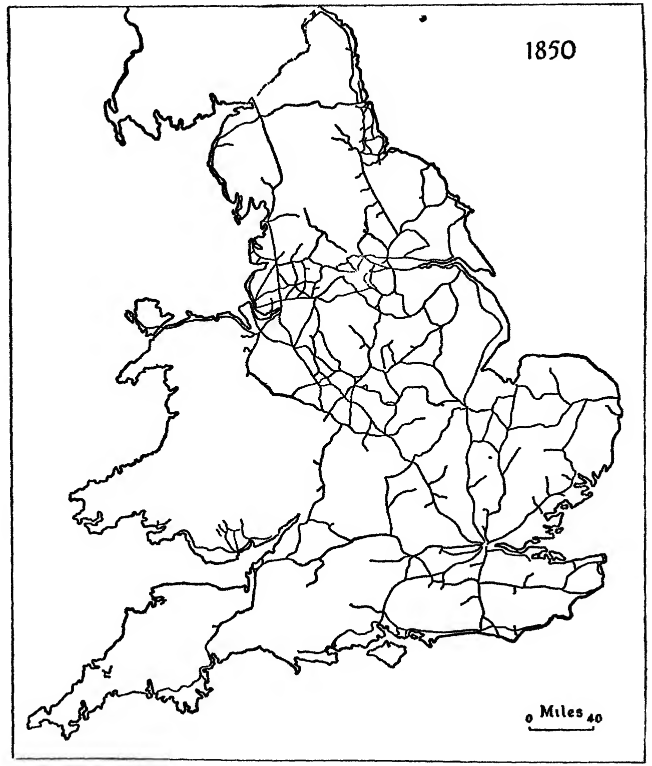


Fig. 20B

RAILWAYS IN ENGLAND AND WALES IN 1840 AND 1850

Maps drawn by Miss M. Salmon. These two maps show interesting phases in the development of the railway network. By 1840 the Lancashire, Yorkshire, Midland and London railways were already linked up, but the North-east Coast railways were still separate and the South-west Peninsula was not yet linked with London. By 1850 the net was much more general, but marked rural interstices still persisted in Wales, the South-west Peninsula and the northern Pennines

so completely had the railway caught the imagination of the country.

TABLE XX

Traffic Statistics of Major Railway Companies, 1865

	Route-mileage	Total Goods (tons per mile)	Minerals (tons per mile)	General Merchandise (tons per mile)	Passengers (number per mile)
S.E.	297	3,200	702	2,498	54,350
L.B. & S C.	275	3,895	1,859	2,036	53,312
L. & S.W.	576	2,499	835	1,664	18,400
G.W.	1,256	5,727	3,847	1,880	14,016
L.N.W.	1,274	10,535	7,094	3,441	18,847
Midland	700	13,223	7,646	5,577	15,970
L. & Y.	431	16,335	9,022	7,313	48,048
Caledonian	494	13,988	10,580	3,408	13,342
G. & S.W.	254	13,218	11,667	1,551	10,342
G.N.	440	9,646	5,123	4,523	15,372
G.C.	246	14,793	8,726	6,067	20,253
G.E.	756	3,331	1,171	2,160	17,035
N.E.	1,205	16,278	12,705	3,573	10.686
N.B.	723	7,912	5,775	2,137	10,895

Calculated from C. E. R. Sherrington, *Economics of Rail Transport in Great Britain*, vol. 1 (1928), Tables 1, 3, 4, and 5. Calculations refer to number of tons or of passengers per route-mile.

It is possible to indicate regional differences between different parts of the country in the nature of their railway traffics. By 1865 the railway net was already established in outline, although its route mileage was to be nearly doubled by 1913, and statistics were tolerably complete. Traffic figures for the more important systems are given in Table XX. The 'metropolitan' railways stood apart from all other lines in their heavy passenger traffic and light goods traffic. The South Eastern and the London, Brighton, and South Coast had over 50,000 passengers, but under 4,000 tons of goods per route mile, and their goods were chiefly general merchandise. The railways serving mainly the manufacturing and mining districts had, in contrast, fewer passengers and more goods. The North Eastern presented an extreme case with 10,686 passengers and 16,278 tons of goods per route mile. These industrial railways carried a greater tonnage of minerals than of general merchandise. Only the Lancashire and Yorkshire had a comparable density of passengers, and this served an industrial district with a large interchange of urban populations. These identical contrasts can be drawn with finer and sharper detail for a later period, but they were thus already developed by 1865.

The revolution in industry greatly increased the volume of overseas

trade. The volume of industrial production grew beyond the capacity of the country to provide raw materials and beyond its capacity to absorb finished products; by 1847 it had also become clear that the industrial population was on the point of growing beyond the capacity of the country to support it with food. 'We cannot reasonably expect,' declared Porter, 'that the soil can always be made to yield increasing harvests to meet the constant augmentation of the population.' Already foreign commerce was to Britain 'a thing of social, if not of physical, necessity', and it was soon to become a physical necessity also. The future of the country depended on 'a permanent extension of commercial relations with countries whose inhabitants, being in different circumstances . . ., may be willing to exchange the products of their soil for the results of our manufacturing industry'.[1] Regional specialization of production which had become so marked a feature of the economic geography of Great Britain itself was to be extended to the world order.

The import trade prior to the middle of the nineteenth century was mainly of raw materials and tropical foods, import of grain being spasmodic and infrequent,[2] and import of foreign manufactures being restricted to certain special commodities of which silk and chemicals were outstanding. Of the raw material imports the most important were cotton, flax and hemp, wool, timber, and some metal ores. All the raw cotton and silk had to be imported and an increasing quantity of the raw flax and wool. The large- and medium-sized farms which came to prevail after the Agrarian Revolution were unfavourable to flax growing and the better feeding of sheep in association with the New Husbandry had lowered the quality of the wool fleece and necessitated an increasing import of the finer qualities of raw wool from abroad. Together these textile raw materials amounted to 24·8 per cent of all imports by value in 1854. The import of timber was consequential on the poverty of the British landscape in woodland. Open-field cultivation had denuded the face of the country and enclosure gave rise to hedgerow and coppice wood rather than to standard timber. Import of metal ores was as yet small, though it was increasing in the second quarter of the nineteenth century. Indeed, in the first quarter of the century there had been substantial *export* of copper, tin, and lead ores.[3] The import of tropical and sub-tropical sugar, coffee, cocoa, tea, and tobacco amounted to 12·7 per cent of the total import by value, and of these the largest individually was sugar.

Of the exports the greater part was of manufactures, and of the manufactures textiles and iron goods were the chief, contributing in

[1] G. R. Porter, *The Progress of the Nation* (1847), pp. 352–5.

[2] *Commerce and Industry.* Tables of Statistics from 1815, ed. by W. Page (1919), no. 42.

[3] Clapham, *Early Railway Age*, pp. 240–1. Copper was exported in quantities equal to or greater than home consumption up to the middle of the century.

1854 44·6 and 15·2 per cent respectively.[1] Now, as before the Industrial Revolution, these were the staples of British production. But the largest textile export, even so early as 1815, was no longer woollens and worsteds, but cottons; the export of cotton manufactures amounting to over one-quarter of the entire export. 'It is not surprising that Britain's foreign trade presented itself almost as a problem in cotton, or that Manchester claimed a great share in the determination of the commercial—and industrial and social—policy of the country.'[2] The growing cotton export greatly facilitated the development of trade with the tropics, a trade hitherto retarded by a lack of suitable commodities to exchange for the tropical products required by Britain. By 1853 India and the Far East were taking over a quarter of the entire cotton piece goods export.[3]

TABLE XXI

Geographical Distribution of British Exports, 1827–1913

	1827	1844	1889	1913
Europe and Mediterranean	39·9	43·6	42·4	39·5
Temperate North America	22·6	18·8	16·9	13·9
Temperate South America	1·5	2·7	5·3	5·2
Temperate South Africa	0·6	0·7	3·1	3·9
Australia and New Zealand	0·9	1·3	8·1	7·8
India and Far East	12·0	17·7	16·1	20·1
Tropical Middle and South America	21·4	12·7	6·2	4·6
Tropical Africa	0·4	0·8	0·8	2·1
Others	0·7	1·7	1·1	2·9
Total	100·0	100·0	100·0	100·0

Calculated from G. R. Porter, *The Progress of the Nation* (1847) for 1827 and 1844, and from the *Statistical Abstract of the United Kingdom* for 1889 and 1913.

The geographical distribution of British exports for two separate years towards the close of this phase, ending at the middle of the nineteenth century, is set out in Table XXI. Its world-wide character is clear. Approximately two-thirds was with temperate lands and one-third with tropical lands in 1827, but it was to Europe and the Mediterranean and to the Americas that the greater part of the exports went. The new fields in temperate lands in the Southern Hemisphere were only beginning to be involved. But the distribution was not static and was in fact already changing. While there was increase in the actual volume of exports to almost all regions, there were substantial changes in the proportion taken by each major area. Trade with the Americas had declined relatively in 1844 as compared with 1827, particularly the trade with tropical America, and with

[1] Calculated from Page, op. cit., Tables 23 and 47.
[2] Clapham, *Early Railway Age*, p. 479.
[3] Redford, *Manchester Merchants*, Appendix B.

the British West Indies there was an absolute and not only a relative decline. Trade with India and the Far East, with tropical Africa, and with the temperate lands of the Southern Hemisphere had grown.

Fig. 21 gives the ports of Britain in 1843, the size of the symbol varying according to the gross receipt of customs duty. London was indisputably the largest port of the country, collecting 54·9 per

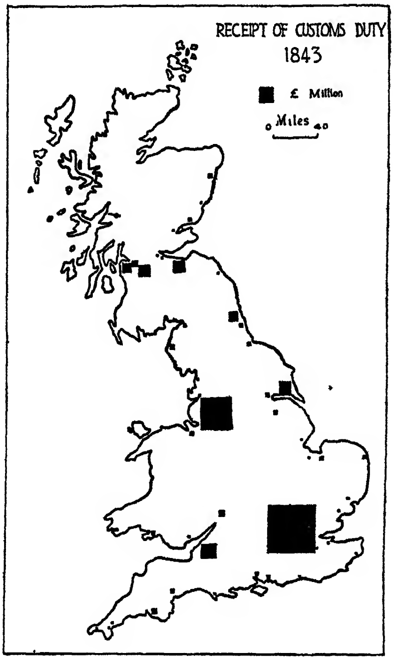


Fig. 21

RECEIPT OF CUSTOMS DUTY BY PORTS IN 1843

The size of the symbol varies in proportion to the receipt of customs at each port. The map indicates the relative value of the *import* trade port by port, but inexactly, for customs duties varied with the commodity and there were variations in the commodity structure of the import trade of each port. Map constructed from list printed by G. R. Porter, *The Progress of the Nation* (1847).

cent of the entire customs of Britain. This, however, is an index of imports rather than of exports, and the predominance of London was more pronounced in the import than in the export trade in the eighteenth, nineteenth, and twentieth centuries alike. In any case, this figure represents a diminution in the proportion of trade handled by London as compared with 1790, and still more as compared with 1700. The Industrial Revolution, by reason of the geographical shift of industry which it had produced, had decreased the pre-eminence

of the port of London. The second port of the country was now not Bristol but Liverpool: Liverpool received 19·9 per cent of the customs of Britain and Bristol 4·8 per cent. Liverpool had become the premier port of industrial England. The fourth port was Glasgow (together with Port Glasgow and Greenock), with 4·5 per cent; the fifth Leith, with 3·0 per cent; and the sixth Hull, with 2·5 per cent. The West of Scotland now handled a larger volume of trade than eastern Scotland and the importance of the west was probably more pronounced in the export than in the import trade. The Industrial Revolution had caused a shift within Scotland as well as within England.

IV

THE LATE NINETEENTH CENTURY

By the middle of the nineteenth century the new industrial economy and the new industrial distributions were firmly established. Britain had become a trade state and its economy was bound up indissolubly with internal and overseas trade. The revolution in internal transport by which the railway solved, for the time being, the internal transport problem, was in process of accomplishment by 1850, but the revolution in overseas transport by means of which steam was substituted for sail was only just beginning on any scale.

In internal transport the railway was indubitably the most important element. The road was employed for little more than local carting. In 1888 the tonnage carried on the major waterways of Great Britain was 34·75 million tons[1] and on the railways 281·75 million tons.[2] But waterways traffic was not declining at all conspicuously. It was 35·4 million tons in 1898 and 33·5 million tons in 1905.[3] Certain individual canals exhibited increase rather than decline. The *Final Report* of the Royal Commission on Canals and Waterways gives particulars for a dozen canals with 41 per cent of the total British mileage and 47 per cent of the total traffic. These dozen waterways show an actual increase of traffic in million tons from 14·0 in 1848 and 14·7 in 1858 to 16·7 in 1888, 18·8 in 1898, and 18·2 in 1905. But, even if there was little change in the total volume of traffic on the canals, the whole of the increased volume of traffic was taken by the railways. Goods traffic on the railways of Great Britain and Ireland grew steadily in million tons from 169 in 1871 to 282 in 1888, 379 in 1898, 461 in 1905, and 568 in 1913.[4] The canals just held their own as a result of inherited traffic, but

[1] Royal Commission on Canals and Waterways, Appendices to *Final Report* (1910), Cd. 5204, p. 23.

[2] Page, op. cit., p. 170.

[3] Royal Commission, Appendices to *Final Report* (1910), Cd. 5204, p. 23. These figures do not represent all canals, but only those which gave returns for each of these three years. The total for 1905 for all waterways was 39·5 million tons (*Final Report* (1909), Cd. 4979, p. 48).

[4] Page, op. cit., pp. 170–1.

the railways went from strength to strength and acquired all the new traffic. In 1905 most canal traffic was local, the average distance travelled per ton on some fourteen canals being only 17·5 miles.[1] The long-distance traffic had been lost to the railways and to the coasting trade. The Royal Commission admitted that long-distance haulage on the canals was not cheap, and that, unless the canals were improved to permit bigger boats, they could not compete with the railways in cost, quite apart from speed. It was asserted in evidence before the Commission by Midland industrialists that, in consequence of the cost of long-distance haulage, whether by rail or by canal, industry was migrating from the interior to the seaboard.[2] There was, in fact, a large migration from the West Midlands at this time of galvanized sheet makers to Merseyside and Deeside. It was the Birmingham district, above all others, that was interested in canal improvement and in the possibilities of cheaper transport which it presented. The Royal Commission drew up an elaborate scheme for canal improvement on routes connecting the Midlands with the four estuaries of Thames, Humber, Mersey, and Severn, but it was never put into effect.

Railway route mileage was practically complete by the 'eighties, though there were a few important constructions, such as the Great Central line into London, after that time. Railway track mileage continued to grow, however, with the double tracking and quadruple tracking of existing routes. The original railways were mostly short independent lines with local objectives and promoted by local men. They were essentially comparable in this respect to the canals and turnpike trusts which had gone before them, and bore witness to the localism still remaining in English life. Almost immediately, however, amalgamation began, much of it 'end-on' amalgamation. The foundations of the Midland, of the London and North Western, of the Lancashire and Yorkshire, of the Manchester, Sheffield, and Lincolnshire (later the Great Central), and of the York, Newcastle, and Berwick (later the North Eastern) were all laid during the 'forties.[3] By 1912 eleven companies controlled 13,631 miles out of a total route mileage in England and Wales of 16,401. Only one of these companies, the North Eastern, had a regional monopoly, but many of the others had pooling arrangements and agreements on running powers which led to regional co-ordination of traffic, which the railways themselves regarded as the elimination of waste, but the trading public as the elimination of competition and of the traders' safeguards. Regional railway groups had emerged and the way was prepared for the Railways Act of 1921. The geographical character

[1] Royal Commission, *Final Report* (1909), Cd. 4979, p. 53.
[2] Royal Commission, *Final Report* (1909), Cd. 4979, pp. 87–9.
[3] E. Cleveland-Stevens, *English Railways, their Development and their Relation to the State* (1915), Chapter XI.

of these regional groups as they existed prior to nationalization on January 1, 1948 will be discussed in a later chapter.

In 1853 the British merchant fleet was still predominantly sail, 3·78 out of a total of 4·03 million gross tons. It was not until 1883 that steam tonnage registered in the United Kingdom first exceeded sail tonnage and by 1913 there were only 0·85 of sail out of a total of 12·12 million net tons. In 1853 steam tonnage was 6·2 per cent of the total; in 1913 sail tonnage was 7·0 per cent of the total—but the change had taken sixty years to accomplish. The *Comet*, with a 3-h.p. steam-engine, plied on the Clyde in 1811 and the Lairds of Birkenhead built an iron steamboat which sailed up the Niger in 1832.[1] It is noticeable that it was on the northern estuaries of Clyde and Mersey, away from the traditional shipbuilding yards of the English Plain, that these new experiments were located. At first, however, steamships were engaged mainly in the coasting trades—the Irish butter trade to Liverpool, for example—and in coastal or local passenger packet services—there were steam-ferries on the Mersey by 1827. But by 1847 steamers were plying across the English Channel to France, from London and Hull to the Low Countries and to Hamburg and from London to Lisbon and Cadiz.[2] But this was not all, for steamships were sailing from Liverpool to the United States, the West Indies, and South America.[3] There was even steamship communication between Britain and Alexandria and between Suez and Bombay, with only a short land portage across the Isthmus of Suez in between. These were, however, skeleton services. There were many iron sailing ships during the decades following 1850, and they were particularly prominent in the Australian wool trade as the handful of their survivors are to-day in the Australian grain trade. The gradual increase in the numbers of iron steamships greatly increased the volume of goods which could be moved on the high seas. They had a greater sailing mileage during the course of the year, though against this had to be set the unremunerative space occupied by engines and bunkers. The difficulty of obtaining coal bunkers and the necessity of carrying large bunker supplies owing to the low fuel efficiency of the early marine engine was a deterrent at first to the employment of the steamship on the long-distance routes.

After the middle of the nineteenth century and the adoption of Free Trade, Britain committed itself irrevocably to world trade as the basis of its economy. It had long been a social necessity, to use Porter's phrase, and it had now become a physical necessity also. The fluctuations of foreign trade were an index to economic conditions at home and fluctuations in the export trade brought prosperity

[1] Clapham, *Early Railway Age*, p. 439. [2] Porter, op. cit., p. 321.

[3] Regular steamship communication across the Atlantic from Liverpool began in 1838.

or depression in industrial Britain. The character of the foreign trade was gradually changing. In 1854 and in 1913 alike import consisted primarily of food and of raw materials and export primarily of manufactures, but by 1913 this was much less completely true than it had been in 1854. Expressed as a percentage of the retained imports, food changed little, but raw materials fell and manufactures increased. Manufactures were 16·5 per cent of imports in 1854, but 24·9 per cent in 1913. Expressed as a percentage of the net exports, food, always a minor element, again changed little, but raw materials increased and manufactures decreased. The increase in raw materials export was chiefly of coal. Manufactures were 91·8 per cent of exports in 1854, but 78·3 per cent in 1913. These percentage changes are of very considerable significance, for they register changes in the trend of the British economy. Britain was less the workshop of the world in 1913 than she had been in 1854. In 1854 exports of manufactures had been nearly four times imports of manufactures, but in 1913 they were only two and a half times as much.

Table XXI shows the geographical distribution of British export trade during this period. A greater proportion of the import than of the export trade was with Europe and North America: it was nearly three-quarters of the total import in 1889, though it had fallen to two-thirds by 1913. Even in the export trade, however, over half was to these nearby lands. With the tropics and with lands in the Southern Hemisphere Britain carried on a balanced trade in which exports equalled or even exceeded imports, but with the temperate lands of the Northern Hemisphere imports exceeded exports. In 1889 imports from the Southern Hemisphere were yet comparatively small, being considerable only from Australasia. By 1913 they had grown substantially, and temperate South America was sending almost as much as Australasia. Imports from the Northern Hemisphere had fallen in proportion, not absolutely but relatively. British imports were thus being obtained from an increasingly wide range of countries and the temperate lands of the Southern Hemisphere were being drawn on to supply food as well as raw materials. Of the export trade a lesser and lesser proportion was going to Europe and North America; in 1844 it had been 62·4 per cent, in 1889 it was 59·3 per cent, and in 1913 53·4 per cent. As the Industrial Revolution on the European Continent and in North America proceeded, their absorption of British manufactures gradually declined. The proportion of the total export going to tropical Central and South America also declined, but not for the same reason. On the other hand, the proportion of the total export taken by the temperate lands of the Southern Hemisphere, by tropical Africa and by India and the Far East increased. British exports were thus diffused throughout the entire world. The trade to China, however, was already on the decline by 1913.

Although London was still the largest single port, its predominance in British foreign trade had fallen still further by 1913. In 1843 London had collected 54·9 per cent of the entire customs of Great Britain, but in 1913 it handled only 33·0 per cent of the imports of the United Kingdom, and 24·9 per cent of the exports.[1] Its export trade was largely the re-export trade of an entrepôt, exports of imported produce being £59 million and exports of British produce and manufacture being £99 million. Liverpool greatly surpassed London in export of British produce—£170 million as compared with £99 million—and was in fact an exporting rather than an importing port, net imports being £150 million. Liverpool and London had the characteristics of an industrial and of a metropolitan port respectively. The third port of the country was now Hull and the fourth Manchester, newly created with the opening of the Manchester Ship Canal. Combined, these three northern ports had a greater total trade than London, greater in import as well as in export. This was the result of the geographical shift of industry and of population consequential on the Industrial Revolution. The fifth port was Glasgow and the sixth Southampton. Glasgow and Greenock had now double the volume of trade of Leith. Bristol, the third port in 1843, had by 1913 fallen to twelfth place. Of the ports of the English Plain, only London and Southampton were in the first rank, and Southampton was little more than a metropolitan outport. London dominated the English Plain, but the English Plain was not now the dominant part of Britain.

[1] The statistical basis of the two returns, however, is different.

PART TWO

THE PRESENT ECONOMIC GEOGRAPHY

do not represent a watertight classification. Grasses in rotation are part of the arable, but some have been sown as preparation for permanent grass, and there are regional differences in classification of grass in this borderland state: 'temporary grass by the ten thousand acres in the Western Counties would be deemed permanent in East Anglia.'[1] It is often very difficult also whether to describe a particular field as improved grass or as rough grazing: it can very often be graded up to the one or allowed by neglect to degenerate into the other. Woodland not infrequently affords rough grazing, particularly open woods near the upper altitudinal limit of tree growth. The statistical classification of land must be regarded with these qualifications, but it must be remembered that the returns made to the Ministry of Agriculture are by farmers who presumably describe their land in terms of the use they themselves make of it. There has been some reclassification of individual fields during the war, however, consequential on the Farm Surveys of 1940. These four major forms of land utilization may be arranged in two groups—the cultivated or improved, comprising arable and permanent grass, and the uncultivated or unimproved, comprising rough grazings and woodland. The distinction between uncultivated and cultivated grass is not an absolute one, but in general terms cultivated grass consists of land which has been sown to grass and which receives some conscious manurial and mechanical treatment, while rough grazings consist of grasses (sheep's fescue, *Nardus*, *Molinia*) and heath plants (heather and cotton grass) which, in Sir George Stapledon's phrase, are 'man-shy', and whose only manurial treatment is the sporadic droppings of stock grazing on them. Woodlands cannot always be designated uncultivated, for some woods are carefully managed and yield a steady income whether as plantations of conifers for pit-props or as coppice for hurdles and fencing. The cultivated land is mainly on the deeper soils and in the warmer climate of the lowlands, the uncultivated mainly on the shallower soils and in the cooler climate of the uplands, but there are heaths and woodlands in the lowlands as well as in the uplands, particularly on light sandy soils.[2]

The *cultivated* land in the lowlands, then, is partly in arable and

[1] J. A. Venn, *Foundations of Agricultural Economics* (1933), p. 438. The same difficulty has been experienced by the local surveyors of the Land Utilisation Survey. The agricultural returns of Eire classify grass of less than five years as in rotation and of five years and over as permanent. Professor Stamp, however, has recently asserted 'Grass which had been down for more than two years was recorded as permanent by the Land Utilisation Survey and is so recorded in the official agricultural statistics' (L. D. Stamp, 'Wartime Changes in British Agriculture', *Geographical Journal*, vol. CIX (1947), p. 44).

[2] Not all lowland timber is on sands or gravel, for there are woods such as those of the Chilterns or Savernake Forest, and there are windbreaks, game coverts, and park timber even on the best soils. Many old coppices once cut over at intervals of ten to twelve years are now game coverts, but many of these were felled during the late war.

partly in permanent grass. We must now consider the factors determining the distribution of arable and of permanent grass at the present day and the extent to which these factors give rise to regional variations in land use. The factors are both physical and economic. All soils are physically capable of being ploughed and, therefore, of being cultivated as arable, but they vary according to their natural fertility and according to the ease or difficulty with which they can be worked. A naturally infertile soil gives such low crop yields that, unless prices are high, the cash return will barely repay costs of seed and of cultivation. Some soils are more difficult and, therefore, more costly to work than others. Heavy clays cannot be cultivated in very wet or in very dry weather, and during the ploughing season they are not infrequently too wet to work.[1] This is more likely to be the case with heavy soils in the wetter western Britain than with heavy soils in the drier eastern Britain. The use of the tractor, particularly the caterpillar, in place of the horse, however, is extending the period during which even heavy soils can be worked.[2] An indication of the difference in respect of cost of working between heavy and light soils is given by figures of labour costs of sugar beet cultivation for 1924–31.[3] Labour costs for heavy soils were one-fifth to one-third higher than for light soils when reckoned as costs per acre, and approximately one-fifth higher when reckoned as costs per ton of beet. Costs of wheat cultivation in the Eastern Counties in 1930–2 show a smaller range of difference (6½ per cent) in actual cultivation costs per acre, but in this sample wheat on heavy clay followed fallow or fallow crops to a greater extent than on light-medium soils, and some cultivations on the clays were already performed and not costed to wheat.[4] It is, therefore, the light soils that tend to be in arable cultivation, for under present economic conditions they have a costs-margin in their favour.[5]

British soils as a whole belong mainly to either the podsol or the brown earth groups. Both are leached soils, for the British climate is humid, but the podsol is leached the more intensely. The brown earths have more bases in their composition and are less impoverished

[1] At Woburn Experimental Station sandy soils have a water content ranging between 1·1 and 14·0, but clay soils between 15·8 and 35·0 (E. J. Russell, *Soil Conditions and Plant Growth* (1937), p. 491).

[2] J. E. Newman, 'Mechanization and British Agriculture', *Rothamsted Conferences*, XIV (1932), p. 22.

[3] R. N. Dixey, 'Sugar Beet: Labour Costs, 1924–31', *Farm Economist*, vol. I (1933–5), pp. 52–3. These labour costs include harvesting and haulage as well as cultivation. The average yield per acre in tons averaged out (1927–32) at about the same for light and for heavy soils. See A. Bridges and R. N. Dixey, *British Sugar Beet* (1934), p. 67.

[4] R. McG. Carslaw and A. L. Jolly, 'Variations in the Cost of Wheat Growing', *Farm Economist*, vol. I (1933–5), pp. 106–7. Yield per acre on the clay was 4·2 quarters, on the light-medium soils 4·4.

[5] See, however, B. A. Keen and E. W. Russell, 'Are Cultivation Standards Wastefully High?', *Journal Royal Agricultural Society* (1937), pp. 53–60.

than a fully developed podsol. There is an important difference, too, in their physical structure. 'Whilst in the podsols the single grain structure predominates, the brown earths are generally distinguished by a crumb structure or a variant of this structure.'[1] The object of cultivation, as soil physicists at Rothamsted constantly stress, is to create and maintain a crumb structure.[2] This is easier with the brown earths than with the podsols, and, in fact, 'the cultivator' of the podsols 'is actually engaged in a perpetual struggle with the conditions which militate against arable culture'.[3] In Britain the brown earths are mainly in the south and east, and the tendency to podsolization increases to north and west; but there are podsols on the sandy heaths of the English Plain and brown earths in loams in western and northern districts. The conclusion is that the general run of soils in eastern and southern Britain is physically more suitable to arable cultivation than the general run of soils in western and northern Britain, but there is, of course, great variation within each district according to the precise character of the parent material.

The influence of soil acidity is substantial. It does not in itself determine whether land should be in arable or in grass, for there are individual crops and individual grasses which are tolerant of soil acidity. But an acid soil is selective of particular crops and of particular grasses. Soil acidity is usually correlated with a deficiency of available calcium, that is, calcium available in a form suitable for plant growth, and the treatment to correct acidity is the application of lime. The degree of acidity is indicated by the pH measurement, the lower the value the greater the degree of acidity. 'In the south of England fertile conditions are associated with pH7, but in the west in Wales, and in Scotland lower pH values, 6·5 or even 6·0, appear to be quite satisfactory.'[4] The limit of acidity in grassland which cattle and sheep will ordinarily tolerate is pH5.[5] Acidity is usually greater in western than in eastern districts. This is displayed neatly in field-to-field acidity surveys in the Merse of Berwick and in Wigton, as representative of eastern and western Scottish conditions respectively. The percentage of fields sampled with pH7 and over was 39·2 in the east and 0·4 in the west, and with pH5·5 and under 3 in the east and 61 in the west.[6] Soil acidity is largely, though not entirely, a function of heavy rainfall or, more accurately, of heavy effective rainfall; that is, of total rainfall less evaporation and run-off. Oats is a typical arable crop in western and northern

[1] G. W. Robinson, *Soils* (1932), p. 213.

[2] For example, 'The essential point is to bring the soil into an aggregation of crumbs and to prevent it falling into a state of dust', *Rothamsted Report for 1935*, p. 45.

[3] Robinson, op. cit., p. 365.

[4] Russell, *Soil Conditions*, p. 538.

[5] Russell, *Soil Conditions*, p. 543.

[6] W. G. Ogg and W. T. Dow, 'An Acidity Survey', *Scottish Journal of Agriculture*, vol. XI (1928), and C. Louden, 'An Acidity Survey', *Scottish Journal of Agriculture*, vol. XII (1929).

Britain, not only because it needs less sunny conditions than wheat and can in fact be cut green, but also because it is more tolerant of soil acidity. *Agrostis* is common and rye grass relatively rare in western regions in permanent grass because the former is tolerant of, and the latter sensitive to, soil acidity.

Apart from its indirect effects through the soil profile and through soil acidity, climate affects plant growth and yield directly. The grains vary in yield in proportion to the amount of sunshine and in

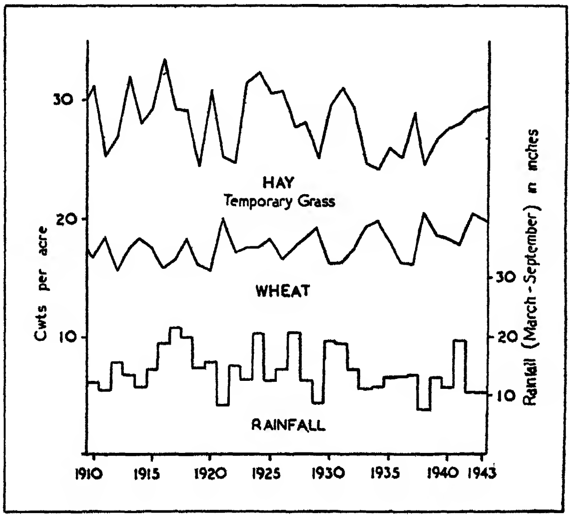


Fig. 22

YIELD OF WHEAT AND HAY AND AMOUNT OF SUMMER RAINFALL ANNUALLY, 1910–1943

Crop yields in cwt. per acre, March-September rainfall in inches.

inverse proportion to the amount of rainfall.[1] Fig. 22 shows peak yields for wheat grain in the hot, dry summers of 1911, 1921, 1929, and 1933. The effect of sunshine and rainfall on the yield of wheat is also neatly brought out in Table XXII, which relates to wheat grown on the Broadbalk field at Rothamsted.

Of the roots, except for mangolds, yields are higher in cool districts than in warm, dry districts.[2] But, although the yield of sugar beet root per acre is higher in the west than in the east, the *sugar content*

[1] Even oats, tolerant of cool wet conditions as it is, shows this tendency, though the yield of oat straw is less and of lower feeding quality in eastern than in western districts (J. A. S. Watson and J. A. More, *Agriculture. The Science and Practice of British Farming* (1933), p. 183).

[2] The yield of turnips and swedes per acre in the ten years 1920–9 was 17·1 tons in Scotland and 12·5 tons in England; of mangolds per acre in 1921–30, 18·2 and 19·2 tons respectively. The mangolds acreage in Scotland is small.

TABLE XXII

Yields of Wheat in Wet and Dry Years at Rothamsted

Plot No.	Treatment	Dressed grain (bushels per acre)		Straw (cwt. per acre)		Weight of dressed grain (lb. per bushel)	
		Wet Yr.	Dry Yr.	Wet Yr.	Dry Yr.	Wet Yr.	Dry Yr.
2	Farmyard manure	16·0	34·2	20·0	20·1	56·8	63·4
3	Unmanured .	4·5	10·7	6·7	5·6	51·8	62·5
6	Minerals + ammonium salts	10·5	19·4	14·2	10·2	56·5	63·1

The wet year was 1879, the dry year 1893. From Table XX, p. 57 (A. D. Hall, *The Book of the Rothamsted Experiments*, 2nd ed., by E. J. Russell (1917)).

is higher in the east with its greater sunshine[1] and its cooler autumn nights.[2] Of the grasses, the yield is higher in moist western districts than in dry eastern districts and on heavy than on light soils, for their shallow root system implies a liability to burn up in dry weather. The annual variation of hay yield, as an indication of the quantity of grass growth, is in inverse proportion to the annual variation of wheat yield, as Fig. 22 shows. Thus, though the yield of wheat is higher in the eastern counties, the yield of hay is higher in the western.[3]

The drier, sunnier climate of eastern and southern districts thus favours grain more clearly than other crops. Although British arable farming, except on some mechanized corn-growing farms, has not now grain as its single objective, nevertheless corn usually takes up one-third to one-half of the arable rotation, and is still (except in specialized arable systems) the pivot of arable cultivation. In so far as the distribution of conditions suitable for corn determines the distribution of arable, it is the eastern districts which are the most favoured arable regions. It is the same regions which develop the more easily a soil structure suitable to arable cultivation. It is significant that those western districts which have an appreciable

[1] The south-western counties had an average sugar content of 17·06 per cent and an average yield of 11·99 tons per acre, while the eastern counties had a sugar content of 17·45 per cent and a yield of 9·33 tons. These were the averages for 1926–32 (Bridges and Dixey, op. cit., p. 68).

[2] Storage of sugar is increased by fall in temperature in autumn, a fall greater in eastern than in western Britain. For the effect of temperature on sucrose percentages, see R. O. Whyte, *Crop Production and Environment* (1946), pp. 275–81.

[3] On the average for ten years (1920–9), the eastern group (Essex, Suffolk, Cambs, Hants, Beds, Herts, Middlesex) had 18·4 cwt. of wheat and the north-eastern group (Norfolk, Lincs, East Riding) 19·1 cwt.; while the south-western (Devon, Cornwall, Somerset, Dorset) had 16·5 cwt., the West Midlands (Wilts, Gloucs, Worcs, Hereford, Salop) 15·8 cwt., and the north-western 17·5 cwt. The yields of meadow hay were 18·2 cwt. and 20·2 cwt. for the eastern and north-eastern; 22·1 cwt., 20·1 cwt., and 23·6 cwt. respectively for the south-western, West Midlands, and north-western groups.

proportion of their area in arable have either a light soil, a low rainfall, or a high percentage of sunshine. South-west Lancashire is an example. Conversely, it follows that, in general terms, the western districts offer more suitable conditions than the eastern for grass growth. With certain exceptions, grasses are more shallow-rooted than arable crops. Dutch data indicate an optimum growth of grass with a water level at 12 inches below the surface, but of arable crops with a water level at 20 inches.[1] Under the low rainfall, and therefore low water-level conditions, of eastern England, grasses are apt to burn up in the summer, but their growth is more readily maintained under the higher rainfall, and therefore higher water level, of western England. Where land in the west is cultivated on an arable rotation, rotation grass usually (except in South-west Lancashire) takes up a larger proportion of the arable than in the east. This is the long ley, which, in its primitive form of land tumbled down to grass as a rest from continuous corn cultivation, has long been an established practice in western Britain.

But not the whole of the warmer and drier southern districts is in arable. The operation of economic factors has restricted arable cultivation even within this area. The collapse of corn prices consequential on the import of cheaply produced corn from virgin colonial lands and, secondly, the rise in wage-rates in Britain consequential on the Industrial Revolution, a double change which eroded profitability from both ends, made corn-growing unprofitable on all but low-rented land on cheaply worked, light soils even in the dry climate of eastern England, naturally suitable to corn.[2] There are, of course, some exceptions to this generalization and the reinstitution of fiscal protection together with government orders have greatly modified the arable pattern.

Side by side with the unprofitability of *standard* arable farming on all but low-rented light soils in eastern Britain, has been the profitability of other forms of agricultural enterprise. Consumers' preferences and the dietary of the country have changed:[3] less bread and more meat, more milk, more fresh vegetables and fruit are now consumed than formerly. Grain, moreover, can be transported

[1] Russell, *Soil Conditions*, p.502. See also *Agricultural Progress*, vol. XXIV (1949), p. 113.

[2] The average rent of mainly arable holdings in England and Wales in 1925 was 26*s*. per acre, and of mainly pasture holdings 36*s*. per acre (*The Agricultural Output of England and Wales, 1925* (1927), Cmd. 2815). In 1931 the average rents were 23*s*. and 32*s*. respectively (*The Agricultural Output of England and Wales, 1930–6* (1934), Cmd. 4605). The returns of the National Farm Survey of 1941–3 are not immediately comparable. All pasture types of holding had an average rent of 25*s* per acre and all arable types 26*s*., but sample specific types had the following average rents per acre—dairying 34*s*., grazing and dairying 26*s*., corn and sheep 18*s*., heavy land arable 20*s*. (*National Farm Survey of England and Wales* (1946)).

[3] If consumption per head of each commodity in 1909–13 be placed at 100, then in 1934 consumption of wheat flour was 93, of meat 106, of butter 157, of vegetables 164, of fruit 188, and of eggs 146. In 1948–9 as compared with pre-war (=100), it was 119 for flour, 64 for meat, 50 for butter, 92 for eggs, 142 for liquid milk. These are the results of rationing: only milk shows the continuance of pre-war trends. *Food Consumption Levels* (1949), Cmd. 7842.

from the ends of the earth and can be stored without deterioration, but milk and fresh vegetables must be produced close to the point of consumption or within a short journey, and the same was true of meat and fresh fruit until the employment of refrigeration on a large scale. Grain prices, unless affected by Government action, have been dictated by costs of production on cheaply worked virgin colonial lands, with a low yield per acre, but with a high yield per unit of labour employed.[1] Milk and vegetables, on the other hand, are not affected by costs abroad, except to a small extent. The prices of these farm products have, therefore, moved differentially. The movement can be stated with some precision for the inter-war period. Taking the wholesale prices of each group for 1911–13 as 100, the index number of all agricultural produce in 1935 was 117, for cereals and crops 96, for live stock and live stock products 121, and for fruit and vegetables 184.[2]

These variations in price trends between one commodity and another are of great significance in their effects on type of farming. Arable farming with or without stock is the lowest in the scale, followed in turn by potato and vegetable growing, milk production, and fruit farming; but fruit prices were exceptionally high in 1935 and are ordinarily more comparable to vegetable prices in level as compared with 1911–13. Clearly, standard arable farming, with or without stock, had by 1939 become the least profitable of all alternatives, although its relative position had been somewhat improved by Government assistance which raised the cereal and crop index in 1935, for example, from 96 to 107 and the livestock and livestock products index from 121 to 126. Apart from the exigencies of war and its aftermath,[3] standard arable farming tends to be practised only on land unconvertible to permanent grass or to specialist systems of arable cultivation. Where climatic and transport conditions are favourable, fruit or vegetables are a more profitable use of light fertile soils, but these crops exhibit wide variations in production and price from year to year. The growth of motor transport has greatly increased the area available for market garden crops which, in the vicinity of the large centres of population, was formerly limited by the distance of a half-day horse haul. Some market-garden

[1] The incidence of soil erosion in many of these virgin areas in recent years may affect the situation and increase costs of production. In any case, their accumulated fertility has been largely dissipated (G. V. Jacks and R. O. Whyte, *The Rape of the Earth* (1941)).

[2] For wheat it was 68, for barley 100, for oats 94, for fat cattle 91, for fat sheep 127, for wool 80, for milk 176, for butter 89, for cheese 89, for poultry 124, for hay 97, for potatoes 133, for fruit 196, and for vegetables 137.

[3] For the effects of the late war on the distribution of arable see Stamp, *Geographical Journal*, vol. CIX (1947), pp. 46 and 39. The following sentences are significant. 'One of the great changes wrought by the war was the re-extension of wheat cultivation to a greater or less degree over practically the whole country. The need for bread meant an emphasis on wheat production despite adverse soil and climatic conditions . . . cost of production assumed secondary importance.

commodities are transported considerable distances, from the West Lancashire coast to West Riding towns or from South Lancashire to the West Midlands, from Norfolk to London and the towns of the Midlands, for example; and the practice of the railway companies in recent years under the system of Agreed Charges has tended to extend the range of distribution from the larger producing areas where supplies are available in bulk. Farmers, as well as specialist market gardeners, grow vegetable crops for human consumption, especially potatoes, peas, carrots, and the *brassica* crops.[1] This is true of several parts of the country, but particularly of the Fenland and South-west Lancashire. The adoption of dairying on grass for the sale of liquid milk has been more extensive, particularly on heavy soils. It has become the standard form of land utilization in the vicinity of large centres of population, wherever a good grass sward can be established. But, with facilities in rail transport for long-distance carriage and in motor transport for local collection, liquid milk production has been pushed back into heavy or medium loam grass districts remote from centres of consumption, into districts formerly making butter or cheese or rearing young stock. The growth of this prior to 1913–14 has been indicated in Chapter I. On the eve of the war of 1939–45, therefore, standard arable farming was near to its minimum and as a dominant regional activity was mainly in lands of unconvertible husbandry. All the land naturally suited to grass and most of the convertible land, suitable for either arable or grass, according to whichever is the more profitable, was then in grass. Economic factors, as well as physical, have thus greatly affected the quantity and the distribution of the arable within the cultivated land. This was the position before the late war, during which Government regulation of farming modified agricultural distributions, though its effects have been in very general terms modifications of existing practices[2] rather than *complete* revolutions in practice.

Grass farming is more profitable to the farmer than arable farming on heavy and on convertible land because the land is cheaper to work relative to the return obtained. It is, however, as usually practised, 'skimming' the land, and it gives a substantially lower output per acre than arable. By reducing all crops and grass to the common denominator of starch equivalents it is possible to compare output from arable and from grass. On a standard arable rotation of wheat–turnips–barley–seeds, the average annual starch equivalent (including straw) is 1,540 lb. per acre, but for grass, assuming it to be made into average meadow hay, it is only 721 lb. starch equivalent

[1] This point is developed by P. E. Cross, 'Extension of Market Gardening into Agriculture', *Agriculture: To-day and To-morrow* (1945), ed. by E. J. Russell (1945).

[2] Such as the increase of arable acreage on arable and mixed farms, the ploughing of a few fields on grass farms to provide winter stock food formerly supplied by imports.

per acre.[1] This figure of output from grass requires some addition to allow for the aftermath, the growth of grass subsequent to hay-making, but, even after this correction has been made, the average output of food per acre from permanent grass is little more than half the average output of food per acre from arable. The matter may be expressed in another way in terms of meat and milk production. Grass containing 721 lb. starch equivalent would support a 10½ cwt. cow yielding 2 gallons daily for approximately 71 days or an 8 cwt. beef steer putting on 1½ lb. live weight increase per day for approximately 87 days. This represents less than three months' feed, and stock must perforce be fed supplementary foods if they are to continue production on this scale or else their production must be at a lower rate. Sir Thomas Middleton made a substantially similar estimate when he placed the average annual return per acre of British grassland at 72 lb. of meat[2] and 133 gallons of milk. The best grasslands produce more than this—up to 200 lb. of meat,[3] implying almost 2,000 lb. starch equivalent—but it is only the very best fatting pastures that are capable of this level of production. Sir Daniel Hall's conclusion in 1920 was 'the crops from land under the plough, when used for feeding cattle, will produce of either meat or milk more than twice as much as the same land will yield when under grass'.[4] The average quality of grassland, however, is capable of great improvement, and this ratio is by no means fixed.

The natural vegetation of Britain is woodland, apart from the higher altitudinal limits with semi-tundra conditions, apart from some downland and light sand areas, and apart from the exposed sea coasts. But this natural vegetation has been gradually transformed by biotic interference, the action of man and beast. Woodland has been felled and the grazing animal has prevented its regeneration. In time natural woodland became limited to remote hill districts and was there allowed to persist only on the steeper rockier slopes. Of the uncultivated land, by far the greater part is now in rough grazings. There is little purely natural woodland remaining and most of the semi-natural woodland has been cut over or grazed at some time, thereby altering its composition and the balance of species within the plant association. 'The nearest approach to the truly natural are the beechwoods of the Chilterns, the Cotswolds, the North and South Downs, and elsewhere; . . . the oak woods of the clays and loams . . .

[1] The figures for each crop are: wheat, 1,419 lb. starch equivalent (grain) and 411 lb. (straw); barley, 1,296 lb. (grain), 563 lb. (straw); oats, 1,053 lb. (grain), 595 lb. (straw), potatoes, 2,592 lb.; turnips, 1,494 lb.; seeds hay, 976 lb.; meadow hay, 721 lb. The crop yields are from the *Journal Ministry of Agriculture*, vol. XLIV (1938), p. 1129, and the straw yields from Hall, *Agriculture after the War* (1920), p. 94. The starch equivalent figures are from T. B. Wood and H. E. Woodman, *Rations for Live Stock* (1933); these are starch equivalents from the point of view of animal nutrition.

[2] Carcass weights are much less than live weights.

[3] Stapledon, op. cit., pp. 79–80.

[4] Hall, *Agriculture after the War*, p. 32.

of the Wealden area; the oak woods on the lower slopes of the Pennines and in Wales'.[1] There is a good deal of scrub and bracken, that is, woodland undergrowth, on neglected land, but this is usually classified as rough grazing rather than as woodland proper. The natural woodland in England is mainly of deciduous hardwoods and in Scotland of conifers, but even in England the plantations, trees massed rank on rank, consist mostly of conifers. They are quick-growing and are usually planted on sites where only indifferent deciduous timber would grow. Such plantations have had their opponents, from Cobbett, with his dislike of *Scotch* firs, to the modern aesthete, with his dislike of a rectangular grid superimposed on flowing contours. The replacement of deciduous trees by conifers or by heath may result in podsolization and soil deterioration, for the leaf fall and ground vegetation of deciduous woods maintain the base status of the soil while the absence of these conditions under conifers impoverish it.[2] The rough grazing will be analysed in the chapter on grass farming.

II

REGIONAL VARIETIES OF ARABLE HUSBANDRY: ENGLAND AND WALES

Having thus blocked out the major forms of land use and having thus discussed the factors affecting their distribution, it is now possible to turn to a more specific analysis of the agricultural geography region by region. There is space for only the more highly individualized farming regions. For the classification of other regions not considered here the reader is referred to the maps and reports of the Land Utilisation Survey, and to the maps entitled *Types of Farming*.[3] In writing this account I have drawn extensively on the work of agricultural writers (scientists, economists, and practising farmers), on statistics of sample groups of parishes for which I am indebted to the Ministry of Agriculture, and on my own observations in the field. I will consider the arable regions first.

These involve the entire eastern side of Britain, the driest and, together with southern England, the sunniest part of the country. It is the part most suited topographically as well as climatically, for the most extensive smooth stretches are to be found here. There

[1] Stapledon, op. cit., p. 33. For a fuller examination, see A. G. Tansley, *The British Isles and their Vegetation* (1939).

[2] Robinson, op. cit., pp. 215–16. He quotes Delamere Forest in Cheshire as an example of such deterioration.

[3] Published maps on the scale of one mile to an inch cover the whole of England and Wales and a large part of Scotland. The maps refer primarily to the years 1931–3. The county reports are published as *The Land of Britain*, vols. I–IX (1937–44). In addition there are two sets of maps, each of two sheets, on the scale of 10 miles to an inch drawn up by Professor Stamp, *Land Classification* and *Land Utilisation*.

The *Types of Farming* maps are on the same scale and also in two sheets, prepared by the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland with the help of the Land Utilisation Survey.

are breaks in the arable wherever highland comes down to the east coast, as between Caithness and Moray Firth or between the Lothians and the Merse of Berwick. Arable is not, however, limited to the eastern side of Britain. There is arable in South-west Lancashire, in the rain shadow of North Wales, in the Eden Valley in the rain shadow of the Lake District, and in the South-west Peninsula and the western peninsulas of Wales, which, though wet, are also warm and sunny and are favoured by an early spring and summer. Individual districts show substantial differences in the particular crops grown and in the particular uses to which these crops are put. These differences, as will appear, are closely related to soil, to climate, and to markets.

In the arable districts of South Britain the most extensive single soil type is the chalk, which in 1939 accounted for something like one-quarter of the total arable. Because of its importance it merits some general description prior to the analysis region by region. In general terms chalk soils are light and cheap to work. They are, therefore, suited to arable cultivation under present economic conditions, but their utilization in this way had to await the New Husbandry with its methods of adding humus and of consolidating the soil. The chalk lands, moreover, are in eastern and southern England, whose relatively dry sunny climate is suited to corn. Until the employment of wild white clover, whose horizontally branching habit binds the soil together, it was difficult to develop a good grass sward on these light dry soils (apart from the scanty grazing of sheep's fescue which naturally colonizes them), and they were therefore more suited to arable (or rough grazing) than to permanent grass. All the chalk lands from the Yorkshire Wolds and the Lincoln Wolds through East Anglia, the North and South Downs and the Central Downlands of Berkshire, Wiltshire, and Hampshire to the Western Downlands of Dorset, are largely in arable. They offer an essentially comparable landscape of smooth open country with large rectangular fields, often fenced with wire rather than by hedgerows. The higher summits of the bare chalk, where unmodified by drift, are sometimes fescue pasture and the flat-bottomed valley trenches threading the open uplands are commonly in water meadow. Elsewhere arable prevails.

Though there are substantial variations, as will appear, these chalk lands follow an arable cultivation similar in its general principles. The precise form of cropping varies according to whether it is the Lower or the Upper Chalk, according to whether the bare chalk is exposed or is covered by drift, and according to whether the drift is light or heavy. The foundation everywhere is the Norfolk four-course rotation or some rotation derived from it. 'The four-course rotation in its original form is best suited for light or medium soils in a comparatively dry climate.'[1] Corn takes up half the arable

[1] R. G. White, *Rotation of Crops* (1929), pp. 10–11.

acreage, roots, green fodder crops and rotation grasses the rest. The system provides saleable crops in the form of corn (and now sugar beet), and fodder crops in the form of straw, roots, greens, and seeds. By their manure stock fertilize a soil with no great inherent fertility and enable the round of cropping to be maintained. Sheep treading has long been held to be an additional benefit bestowed on light soils by folding sheep on roots. The matter has been investigated on the light soils of Woburn in Bedfordshire[1] and an effect from sheep treading was experienced to a depth of 10 cm., an effect which persisted after ploughing. Fodder crops are mostly available during the winter half-year, and it is then that stock are kept, being bought in in the autumn for the purpose. In this way labour is well utilized throughout the year, with crops in summer and stock in winter. In its classical form chalk land farming, as just described, produced primarily bread and meat, but its saleable products were all exposed to foreign competition and it produced little of the milk, the vegetables (for human consumption), the eggs, or the fruit which form the most profitable branches of farming in the twentieth century.[2]

In response to these economic conditions chalk land farming has been in process of change during the present century. The changes may be classified into two groups. The first group is of changes to take advantage of the greater profit to be obtained from dairying, from fruit or from sugar beet. The acreage under grass is being increased especially in the form of short leys and attempts are being made to economize in the costs of milk production by the bail method of milking which obviates expensive shippons and minimizes the carting of dung.[3] In East Anglia black currants[4] were at one time during the 1920–30 decade introduced extensively into the arable and in Kent the fruit acreage has expanded substantially. But fruit is not really typical of the dry chalk. Sugar beet has been extensively adopted; it provides an additional cash crop, it serves the same purpose in the rotation as turnips (that is, as a cleaning crop) and the tops and pulp (returned from the factory after the extraction of the sugar) can be fed to stock. The second group is of attempts to adapt prairie methods of farming with its low costs per unit of labour employed. This is the system described as mechanized corn-growing. Both these forms of adaptation have implied changes in the number and in the type of stock kept—more dairy and fewer feeding cattle, fewer sheep and a substitution of grass sheep for the down and the long wool breeds. In the arable counties of the English Plain the sheep

[1] B. A. Keen and G. H. Cashen, 'Studies in Soil Cultivation, VI', *Journal of Agricultural Science* (1932), pp. 126–34.

[2] H. G. Sanders, *An Outline of British Crop Husbandry* (1939), and *Rotations* (1944). Ministry of Agriculture Bull. 85.

[3] A. J. Hosier, 'The Possibilities of Dairy and Poultry Farming on Light Soils', *Rothamsted Conferences*, XVII (1934).

[4] F. Rayns, 'Changes in the Home of the Four-Course Rotation', *Rothamsted Conferences*, VII (1929).

population had declined by 1937 as compared with 1910–12 by over one-third, and in some counties by half.[1] Fully mechanized corn-growing farms in the 'thirties were entirely limited to the chalk lands. They were on light soils, in districts with large fields (over 50 acres), and themselves large farms with an average in 1936 of 736 acres apiece. The physical conditions are therefore suitable for mechanized farming. Most of these farms were derelict before being mechanized,[2] a function of the agricultural depression of 1931, and they were not mechanized until the Wheat Act of 1932 was in force or anticipated; they were to this extent a reflex of temporary conditions, that is, cheaply rented land lowering costs and a guaranteed price increasing returns. The most common system of cropping was a three-course: wheat–wheat or barley–fallow.[3] It is a corn-growing system and the fertility of the soil is maintained by fallowing, as in medieval times, and by adding artificial fertilizers, for, as few stock are kept, there is little farmyard manure available. The yield of corn per acre shows no significant difference from that of the country as a whole. The system, however, was in process of modification prior to 1939 from its simple form of a wholly corn-growing system without stock.[4]

For a systematic regional analysis of chalk arable farming, it is natural to begin with East Anglia, which, as a regional name, applies to the region east of the Oxford Clay Vale and of the Fens and north of the London Clay. The solid geology of Chalk and Crag is largely masked by a mantle of drift, varying in texture from the light blowing sands of Breckland to the strong loams of High Suffolk. The chalk appears from beneath the mantle of drift only at intervals along the scarp summit, and the only substantial continuous area of bare chalk is in South Cambridgeshire, the 'East Anglian Gateway'. There is some variation in rainfall, from over 28 inches annually in North-west Norfolk to less than 23 inches in the flats along the coast, but it is variation in soil rather than in rainfall that is responsible for agricultural diversity within East Anglia. The land use regions of to-day have long been agriculturally distinct from each other, although they

[1] R. P. Askew, 'Recent Changes in Sheep Breeding in the Arable Areas', *Journal Ministry of Agriculture*, vol. XLIV (1937), pp. 451–2. During and since the war decline has gone still further and there are now few arable flocks on the chalk. Costs of shepherding and hurdling together with rationing priorities of dairy cows are the reasons.

[2] A. Bridges and E. P. Weeks, *Mechanized Corn Growing* (1937), pp. 47–8. Rents varied in 1936 from 10*s*. to 22*s*. per acre, an average of 15*s*. 5*d*.

[3] The Rothamsted experiments on Broadbalk field show that it is possible to grow wheat year after year on the same ground. On some plots, adequately manured, there was no deterioration of yield, and where there was deterioration of yield, as on the unmanured plot, the deterioration came to a halt after some twenty-five years (A. D. Hall, *The Book of the Rothamsted Experiments* (1917), p. 36). War Agricultural Executive Committees cultivated mechanically in the same way land previously not adequately used.

[4] Some farms had begun to keep pigs to eat up the straw and the tail corn.

have themselves changed in the precise character of their land utilization with the course of time.[1]

Breckland, in South-west Norfolk and North-west Suffolk, has the lightest soil of all. It is a dry hungry sand, liable to become blowing sand where not fixed by vegetation. There is a large acreage of heath and of coniferous woodland and much of the land which is in arable is marginal, going out of cultivation in times of low prices. Except for the flat-floored river-trenches with their water meadows, neither soil nor climate favour grass, and of the arable only 8 per cent was in 1936 of grasses in rotation. If these light soils are not in arable, they must revert to heath or be planted with conifers. The arable system practised is very fluid and changes from crop to crop according to which is most profitable at the time. Thus sugar beet to-day occupies a large acreage; in 1936 it was 24·9 per cent of the entire arable, a larger acreage than that of any other single crop. There are some cattle[2] on the water meadows, but few sheep are kept despite the light soil and despite the East Anglian tradition of folding sheep on light land. Farming is generally of an extensive kind, and of all the regions sampled by the Cambridge Department of Agriculture in its *Economic Survey of Agriculture in the Eastern Counties*, the Norfolk Breck had per 100 acres in 1931 the lowest figure for landlords capital, for farm capital, for gross income, and for gross output.[3]

The 'Good Sand' region of North-west Norfolk, though also of light soil, is less light than Breckland and has a slightly heavier rainfall. Under a system adapted to its requirements, it is capable of successful arable cultivation except when prices are low. It is typical turnip and barley land, and is suited to sheep folding. Barley is the most important single crop, and much of it in this region is of malting standard. The root acreage is still high, but sugar beet has largely taken the place of turnips and swedes. Beet tops are used for sheep feed during autumn and early winter, and have largely replaced turnips for this purpose.[4] Wheat is grown more than formerly as a result of legislation and direction, and as a result of the availability of breeds such as Little Joss suitable for light land.[5] Few cattle are kept in summer, and these are mainly young stores to be fattened in the yards in winter, though winter fattening of cattle has

[1] The regions are those employed by P. M. Roxby in *Great Britain: Essays in Regional Geography* (1928), ed. by A. G. Ogilvie. 'Good Sand' is A. Young's name.

[2] Dairying has been developed on some land by the sowing of the deep-rooting lucerne with subordinate cocksfoot: this is grazed and an outdoor milk bail employed (A. J. Brookes, 'Milk from the Breckland', *Journal Ministry of Agriculture*, vol. LII, (1944), pp. 444–6).

[3] *An Economic Survey of Agriculture in the Eastern Counties*, University of Cambridge, Department of Agriculture, Farm Economics Branch, Report no. 19 (1932), Table 3, p. 86.

[4] F. Rayns, 'The Beet Crop in Norfolk Farming', *Journal Ministry of Agriculture*, vol. XLIII (1936), p. 43. They are liable to be damaged by heavy rain or frost and must be fed off early.

[5] J. E. G. Mosby in *The Land of Britain*, ed. by L. D. Stamp, pt. 70, *Norfolk* (1938), p. 161.

greatly declined. Sheep were still kept between the wars to a greater extent than in any other part of East Anglia, but equated as live-stock units according to their grass consumption they were even then no more important than cattle.[1] Sheep have to-day largely disappeared.

The 'Rich Loam' region of North-east Norfolk offers interesting contrasts with North-west Norfolk. It consists chiefly of outwash loams and brick earths which have long been under cultivation. The region is an almost continuous spread of arable, broken only by linear threads of water meadow along the stream courses and around the Broads. The region never followed the four-course rotation in its simple form, but intercalated a second corn crop (barley or oats) after the wheat and before the roots, a practice which the richer soils made possible. This extra corn crop is still taken, and the region in 1936 had 58·2 per cent of its arable in corn, the highest percentage of all the sub-regions of East Anglia. The richness of the soil is also evidenced by the absence of bare fallows. Stock kept are chiefly cattle and poultry, and there is an almost entire absence of sheep, a specialization which dates back at least to the late eighteenth century. It is a winter bullock-fattening district, using straw, roots, and hay, but the summer cattle were in 1936 about equally divided between dairy and non-dairy. Dairying has increased and fattening has declined. The alluvial flats of Broadland afford summer grazing for the cattle of North-east Norfolk. The summer density of cattle in Broadland is the highest of all parts of East Anglia, and this again was in 1936 equally of dairy and of non-dairy beasts.

High Suffolk in the central part of the county has the strongest soils of East Anglia. It is the nearest approach to wheat and bean land in the district and the root acreage, relative to the total arable, was less than elsewhere. Over 5 per cent of the arable acreage was in 1936 in summer fallow, another indication of a strong soil. There has been, as might be expected from the soil, a good deal of land laid down to grass as an adaptation to the general lack of profit in inter-war years from standard arable farming. The pattern of land utilization has become a patchwork of arable and grass, quite unlike the masses of continuous arable threaded by riverine strips of grass which is the pattern in the 'Rich Loam' region. There has been some increase in the cow and in the grass sheep population consequential on this increase of grass, but feeding cattle still outnumbered dairy cattle in 1936. The region is remote from centres of milk consumption and is badly served by railways. The pig and poultry density was a high one prior to 1939, and pigs and pig products then formed a very important element in the gross income, amounting in 1931 to over one-fifth of the total.[2]

[1] For the problem of equating different classes of livestock, see W. Smith, 'A Live-Stock Index for the Fylde District of Lancashire', *Empire Journal of Experimental Agriculture*, vol. VII (1939).

[2] Relative stress on feeding cattle, pigs and poultry was still true in 1949.

The 'Sandlings' of East Suffolk is an area of light land, heath in its natural state. Much of it has been reclaimed. As is to be expected, it is largely an arable district and the permanent grass is limited to the flat riverine lands at or near water-table level. Within the arable, rotation grass occupies a very minor place and roots a relatively prominent place, both features in eastern England being attributes of light land. The proportion of the arable under corn is of only moderate proportions and little wheat was grown before the late war. It is a suitable market-gardening soil and, being in contact with the London market by sea, it has grown carrots in quantity from Arthur Young's time. Together with Breckland, it has a larger acreage to-day under market-garden crops than other parts of East Anglia.

The bare chalk of South Cambridgeshire is the only district in East Anglia where the chalk is unobscured by drift. It is a region of large farms, chiefly in arable, and cultivated on an elaborate scale. The sample of farms investigated by the Cambridge School of Agriculture in 1937 exhibited a high level of gross income and of productivity.[1] They practise an arable-cum-stock system, but the stock are not as important as in most other parts of East Anglia, and the direct sale of crops then accounted for almost exactly half of the farm income.[2]

The distinctive arable regions of Kent, Surrey, and Sussex, are on soils other than the chalk. The Thanet Beds, a narrow linear belt along the northern foot of the North Downs and lying mostly about the London–Canterbury road,[3] are almost entirely in arable. The soil at its best is 'a fine loamy sand, easy to work, grateful for manure, generally amply supplied with sub-soil water and resisting drought well'.[4] Sub-soil water may be attributed to topographical position rather than to nature of soil. Some of it is in normal arable cultivation and there is a good deal of market-garden land specializing on potatoes and cabbages, particularly towards London. The brick earths of West Kent and Middlesex, where they are not built over, are under intensive market-gardening. The use of the motor lorry is increasing the range of vegetable production for Covent Garden and the growth of suburban London is pushing market-gardening

[1] *Changes in the Economic Organization of Agriculture*, Cambridge Department of Agriculture, Farm Economics Branch, Report no. 26 (1938). See also for changes, 1931–6, R. McG. Carslaw and P. E. Graves, 'The Changing Organization of Arable Farms', *Economic Journal*, vol. XLVII (1937) and *Farm Economist*, vol. II (1936–8).

[2] A systematic review of war-time changes up to the 1943 season has been issued as *Changes in the Economic Organization of Agriculture*, Cambridge Department of Agriculture, Farm Economics Branch, Report no. 29 (1945). The report shows that the reactions of each sub-region of East Anglia to the war have not been identical, despite the overall influences of commodity prices and controls.

[3] J. Grant, 'The South-Eastern Counties', *Regional Types of British Agriculture*, ed. by J. P. Maxton (1936), p. 147. 'A strip of country about three miles wide roughly one mile to the north of the road and two miles to the south.'

[4] A. D. Hall and E. J. Russell, *Agriculture and Soils of Kent, Surrey and Sussex* (1911), p. 89.

farther and farther afield.[1] But farther still from London, the Sittingbourne district had in 1936 53·1 per cent of the entire arable in orchards, small fruit, and hops. This is not, of course, arable in rotation, for hop yards do not require replanting oftener than every fifteen years, and orchards have a still longer productive life. The soil is rather too light for hops, and it is arable and grass orchards that occupy the greatest acreage—48·7 per cent of the entire arable in 1936. Apple, pear, and plum orchards have usually arable crops beneath, but cherry orchards a grass sward closely cropped by sheep.[2] Young orchards have alternating rows of apples and plums with bush fruit beneath; as they grow older first the bush fruit are removed and then the plums, leaving the apples alone. The grass sward of the cherry orchard limits the amount of moisture available for the tree, and obliges it 'to form short-jointed fruit-bearing spurs instead of coarse wood';[3] it also helps to prevent the fruit cracking when ripening, which might result if too much moisture were available at that period. It is this orchard sheep grazing that is responsible for the high sheep density in the Sittingbourne district, where it is three times as high as in the country as a whole; it includes a substantial number of fattening sheep as well as of ewes and lambs. Hall did not find this fruit district scenically attractive—'a dusty, harsh, businesslike look . . . rarely suggests agricultural richness'[4]—more like a factory imposed on the landscape than a farm melting into it. The fruit acreage in East Kent is increasing, for it represents, as explained above, a more profitable use of the land than standard arable practice.

On the other side of the North Downs the Kentish Lower Greensand is equally under specialist cultivation of fruit[5] and hops, the former tending to increase during the inter-war period at the expense of the latter in accordance with changes in national habit at that time. In the centre of the Mid-Kent district in 1936 three-quarters of the arable was in fruit and hops and the arable itself occupied 70 per cent of the cultivated acreage. Hops are grown on the deeper loams, on the downwash from the Lower Greensand and on the alluvial soils and brick earths of the Medway Valley. Hops require, as a rule, rather stiffer soils than fruit, and with the substitution of fruit for hops in recent years most of the lighter soil at the higher levels is now in fruit, all the more so as these situations are free from frost pockets due to temperature inversion and the drainage of cold air down the slopes.[6] Conversion to fruit has been facilitated by the

[1] E. C. Willatts, *The Land of Britain*, ed. by L. D. Stamp, pt. 79, '*Middlesex and the London Region*' (1937), p. 196.

[2] N. B. Bagenal, 'The Kent Cherry Orchards', *Journal Ministry of Agriculture*, vol. XLV (1938).

[3] Hall and Russell, op. cit., p. 36.

[4] A. D. Hall, *A Pilgrimage of British Farming* (1913), p. 57.

[5] W. A. Bane and G. H. Gethin-Jones, *Fruit-growing Areas on the Lower Greensand in Kent* (1934). Ministry of Agriculture Bull. 80.

[6] Raymond Bush, *Frost and the Fruit-grower* (1945).

common practice of interplanting hop yards with standard fruit trees and of removing the hops when the fruit trees have become sufficiently well established. The hop acreage was stabilized before the late war by the Hops Marketing Board, whose object was to maintain stability of prices.[1] Of the hop and fruit acreage in a sample of parishes in 1936, some 15 per cent was under hops and some 4 per cent under small fruit in the field, the rest, over 80 per cent, being under orchards, some of which had small fruit interplanted beneath the standards.

The West Sussex maritime plain, betwixt the South Downs and the sea, has a surface soil mainly of brick earth, 'the most generally fertile soil in the area', easy to work, holding water well, and underdrained by resting on chalk. Except along the water-courses, it is in arable cultivation of a standard rather than of a specialist type. It is no less sunny than Kent and is indeed the earliest corn district in the whole country. Lack of specialist cultivation in the past was due to the lack of an immediately adjacent market such as Kent had in London. With the growth of the Sussex coast resorts in the last quarter of the nineteenth and in the twentieth centuries, market-gardening and glasshouse cultivation have increased rapidly, especially at the eastern end of the maritime plain in the vicinity of Worthing. Standard arable farming in the area aims at as frequent corn crops as possible, a common rotation being roots–corn–corn–seeds–corn–corn. The corn grown is chiefly wheat and oats, and the crops are heavy and early. Hall labelled the region the 'Sussex Corn Belt'. The density of stock in summer is not very high, but there is much cattle and sheep fattening in winter on roots and hay and straw. The market-gardens specialize on early potatoes, peas, and cabbages. Cultivation under glass is of tomatoes, grapes, cucumbers, and flowers. For all of these there is a large local market.

The Central and Western Downlands to the west of the eroded Wealden anticlinal structures constitute the largest expanse of chalk downland in England. Unlike East Anglia, they are free of drift.[2] The depth of soil varies from four or five inches on the downs to deeper soils, whose depth has been increased by soil creep, just above the valley floor. As on the South Downs, the summit hills, particularly on the Upper Chalk, are frequently in natural fescue pasture. Some parishes on Salisbury Plain have a greater acreage of rough grazing than of improved or cultivated land, though in this instance it is unusually high owing to the presence of troops and the space required for their training. The drift-free chalk with its summit rough grazings is thus different from the drift-covered chalk of East Anglia, which is in arable. The arable and grass lie below this level

[1] It increased again from 1943 onwards. *Hops, Report of Second Reorganisation Commission* (1947), Table 3.

[2] That is, regarding Clay-with-Flints as a residual soil more or less *in situ*.

and stretch down to the edge of the flat-bottomed river trenches which thread the chalk uplands. The chalk, where unmodified by drift, is not a very fertile soil; it is very liable to weeds and yields crops little more than half as heavy as those of famed corn districts such as the maritime plain of West Sussex. But it is light and easy to work, and to a large extent the alternative management to arable is rough grazing. The establishment of an improved grass sward, however, is easier in the Western Downlands than in East Anglia owing to the higher rainfall, which is 35–40 inches on the Dorset Downs, as compared with 23–28 inches in Norfolk: it is also assisted by the methods of open-air dairying and of poultry folding associated with the name of A. J. Hosier and developed in this district. The Western Downlands are, therefore, less completely in arable than is East Anglia, and, having grass, they keep stock on the farm the year through and not only for winter feeding, a further point of contrast with East Anglia.

The Berkshire Downs are largely in arable, the terraces of the Lower Chalk almost wholly so, but some of the Upper Chalk is in sheep walk or used as horse gallops. Like much of the Hampshire Downs, it is thin land and liable in times of low corn prices to fall out of cultivation, now as in Cobbett's day. It is one of the regions where mechanized corn farms are most numerous. The system of cultivation is a four-course or a five-course, with two or three corn crops respectively.[1] 'Roots are not always successful'[2] and the percentage of bare fallow was (*c.* 1930) as high as 15 per cent of the arable. The Berkshire Downs and the Hampshire Downs stand out strongly on the map of bare fallow of England and Wales.[3] Most of the other areas having a large proportion of bare fallow are districts of stiff soils such as Holderness or West Cambridge or North-west Essex. Few other chalk lands have so high a proportion. Wheat, oats, and barley, are all grown. There is an important local market for oats in the racing stables of the area.[4] But the density of cattle and of sheep is below the average for the country as a whole.

The Wiltshire chalk has a higher proportion of permanent grass than the Berkshire chalk, a function of a more westerly situation and a higher rainfall. Some of it is not strictly permanent, but grass in long ley in a system of alternate husbandry, destined to be ploughed, after grazing by a dairy herd or a flock of grass sheep. Subsequent cropping takes advantage of the fertility accumulated during years of grazing and of animal droppings, and permits the renovation of grassland become sheep-sick.[5] The acreage of permanent grass, however,

[1] N. H. Pizer, *A Survey of the Soils of Berkshire*, University of Reading, Faculty of Agriculture and Horticulture, Bulletin 39 (1931), pp. 40–4.
[2] Pizer, op. cit., p. 40.
[3] M. Messer, *An Agricultural Atlas of England and Wales* (1932).
[4] J. Stephenson in *The Land of Britain*, pt. 78, *Berkshire* (1936), p. 86.
[5] T. K. Jeans, 'Modernizing and Mechanizing . . . on the Wiltshire Hills', *Journal Ministry of Agriculture*, vol. XLV (1939).

was increasing steadily before the late war, but here, as elsewhere, permanent grass declined and leys increased during the war. Both permanent grass and long ley are indicative of the approach to western England. The traditional system of farming of the Wiltshire chalk was one of arable and of sheep. The valley trench gave hay, the summit down rough grazing, and the intervening slopes were in arable cultivated on courses whose length depended on the depth of the soil, the best land sometimes growing wheat every alternate year and the thin land wheat every fifth or sixth year.[1] This pattern of land utilization is still exhibited in the upper Avon Valley. The object of the arable cultivation, in addition to corn for sale, was to grow sheep feed—turnips, swedes, rape, vetches, kale—for every month of the year, the sheep being grazed on the hill during the day and folded on arable crops during the night. In order to get as many such crops as possible, the Wiltshire form of the four-course rotation exhibited two successive corn crops, followed by two successive years under green crops, by which arrangement three rather than two green crops could be taken in the two years.[2] With modifications, this arable system is still practised. Turnips are still grown extensively and have not been replaced by sugar beet, the soil being too shallow, and there has been little specialist cultivation on this thin, poor land. The sheep kept used to be mostly the Hampshire Down, whose outstanding characteristics are the early mating of the ewe and the rapid growth of her lambs. But the Hampshire Down has declined greatly since the 1914–18 War: in 1910 there were 255 registered flocks of Hampshire Downs in Wiltshire, but in 1935 only 77.[3] It has been crossed extensively with grass ewes, the progeny fattening early and the ewes themselves being adapted to grazing. Many pure flocks of grass sheep have also been introduced: Cheviot, Kerry Hill, Blackface, and the Half-bred. Dairying, formerly the preserve of the Vale of North Wiltshire, has also increased on the chalk. Some parishes of the Marlborough chalk, however, had in 1936 more dairy cows in calf than in milk on June 4, and there may be some arrangement whereby dairy farmers of the Vale send their dry cows on to the hills until they are about to calf again. Reckoned as grazing units, cattle were even in 1936 as important as sheep. During the war Wiltshire lost sheep as heavily as the other Chalk lands of England.

The Dorset Downs practise an essentially similar type of farming. L. E. Tavener describes them, in terms of land use, as an 'arable-sheep area'.[4] As a function of their still more westerly situation and higher rainfall, they have more permanent grass than the

[1] Jeans, op. cit., p. 1208, and Hall, *Pilgrimage*, p. 4.

[2] The risks of this practice in encouragement of parasitic infestation are described in *Alternate Husbandry* (1944). Imperial Agricultural Bureaux. Joint Pub. No. 6.

[3] Askew, op. cit., p. 565.

[4] L. E. Tavener, *Land Classification in Dorset* (1937), p. 51.

Wiltshire Downs and a greater proportion of rotation grass within the arable. Turnips and swedes are grown more extensively and green fodder crops less extensively. The Dorset Horn and Dorset Down lamb even earlier than the Hampshire Down, and by June 4 the date of the agricultural returns, many of their lambs have already been sold. On June 4 there is a higher density of cattle than of sheep when equated as grazing units, but many of these cattle are kept in summer on the flat valley floors within the chalk uplands and not on the rolling chalk proper. It is clear that western chalk farming, with its grass, its longer leys, its grass sheep, and its dairy cows, presents important points of contrast with chalk farming in eastern England.

The Cotswolds are an arable upland similar to the Downs, and they have had a not dissimilar agrarian history. Though like the Downs in morphology, they represent a landscape of different aspect —brown soils, stone walls, and stone-built villages. They are much less liable to suffer from drought and much more able to develop a good grass sward than the chalk, owing to a higher rainfall and a lesser porosity. There is a little rough grazing on the scarp edges, but much less than on the drift-free chalk, and there is a good deal of permanent grass of indifferent quality. The rotation grass—and this is indicative of the approach to western Britain—is often left down as a ley for two or more years. On sample parishes in the Northern Cotswolds in 1936, rotation grass took up 41·5 per cent of the arable and in the Southern Cotswolds 47·6 per cent. Comparatively little barley is now grown and wheat is the most important cereal. This was so even before the Wheat Act and the late war. Roots and green fodder crops are not grown as extensively as formerly, owing to the substitution of grass sheep and of dairy cows for arable sheep. The old Cotswold breed is now virtually extinct, and it was rare in 1911 when Hall toured the Cotswolds.[1] It has been replaced by the Oxford Down, an arable sheep formed out of the Cotswold and of the Hampshire Down, but this in turn is being replaced by grass flocks—Kerry Hill, Cheviot, Half-bred, Ryeland, and Clun Forest. In 1910 there were sixty-three registered flocks of the Oxford Down in Gloucestershire and Oxfordshire combined, but in 1935 there were only seventeen.[2] Relative to grazing capacity, cattle now greatly outnumber sheep. The cattle comprise chiefly dairy cows and grass-fed bullocks, one to two years old, though there are young stock in addition and a few over two years old. Prof. Scott Watson writes, 'twenty years ago the Cotswold Area was concerned chiefly with corn, sheep, and the rearing of store cattle, while dairying was quite exceptional. Nowadays milk cans are to be seen at nearly every road-end.'[3] It is an arable district in the throes of change, a change

[1] Hall, *Pilgrimage*, p. 170. [2] Askew, op. cit., p. 564.
[3] J. A. S. Watson, 'Some Impressions of British Farming', *Journal Ministry of Agriculture*, vol. XLI (1934), p. 467.

made easier by its westerly situation and the qualities of climate that this implies. It is much more nearly convertible land than is the chalk.[1]

The Bunter sands of Sherwood Forest in Nottinghamshire have their closest analogues in Breckland. They are dry, hungry soils, with a strong tendency to soil acidity,[2] and lacking in humus. Over much of the area the alternative forms of land utilization are rough grazing and arable, permanent grass being possible only by the river-sides. In the eighteenth century much was rabbit warren. Successful arable cultivation depends on frequent dressings of lime to correct soil acidity, and on the keeping of live stock, especially stall-fed beasts, in sufficient numbers to add manure and humus to the hungry soils. A suitable rate of stocking is one sheep per acre.[3] In times of agricultural depression expenses on lime and fertilizers and purchased stock foods are cut down and the stocking of the land reduced. The land then rapidly deteriorates in quality and the farmer is obliged to reduce his expenses still further. The land-owner is frequently compelled to reduce his rent in order to keep the farm in occupation, for unoccupied land rapidly reverts to heath and scrub. Under such circumstances, therefore, the land quickly becomes marginal, if not, indeed, sub-marginal. The cropping system is the Norfolk four-course or a five-course in which the rotation grasses are left down for two years. Most of the crops are intended for feeding to stock, but wheat, sugar beet, and potatoes, are grown for sale, though yields are low. Yields are, in fact, very dependent on sufficient and suitably distributed rainfall, and S. M. Makings, after an examination of the monthly distribution of rainfall over a sixty-year period, goes so far as to say that 'nearly two years out of three failed to provide sufficient rainfall during the critical months to ensure adequate crop growth'.[4]

In Lincolnshire we are back again in eastern England, and arable farming has eastern rather than western characteristics. The Oolites of Kesteven and of Lincoln Heath farther north have approximately two-thirds of their cultivated land in arable. The ridge is here smooth and there are no topographical obstacles to the plough. The area, moreover, is drift-covered.

Lincoln Wold, like the East Anglian chalk, is overlain in part by

[1] A sample of eighteen Cotswold farms, with an average of 54 per cent of their acreage in arable in 1945, had 53 per cent of their total farm production from milk, reckoned in terms of cash.

[2] H. T. Cranfield, 'The Soils of Sherwood Forest', chapter in S. M. Makings, *Farming Forest Sand* (1938). The average pH for seven analyses is 5·3.

[3] Makings, *Farming Forest Sand* (1938), pp. 44–5.

[4] Makings, *Farming Forest Sand*, p. 16. This is based on the assumption that the rainfall of April and May together must be more than 4 inches to ensure adequate growth. It is a rather arbitrary criterion and takes no account of the moisture residues left over from winter. Many other parts of Britain would have an equally deficient rainfall on this standard.

boulder clay. It is also of moderate elevation, has few slopes too steep to plough and few summit areas high above the water-table. Lincoln Wold, like East Anglia, is thus very different from the drift-free chalk south of the Thames. For these reasons, though the soil is often thin, the acreage under rough grazings is low and, ever since the New Husbandry made arable cultivation on these soils possible, they have been, and still remain, in arable. Having light soils and a low rainfall, Lincoln Wold is not readily convertible to permanent grass. It is typical turnip and barley land, but, though it retains this character on the thinner soils of the Central or High Wolds, it is less completely so on the deeper soils of the North or Low Wolds. In the High Wolds even the Wheat Act of 1932 caused substitution of wheat for barley to only a restricted extent, but in the Low Wolds the wheat acreage now exceeds the barley. Similarly, while in the High Wolds the turnip and swede acreage was in 1936 some 17·5 per cent of the arable, in the Low Wolds it had declined from this level during the previous twenty years to some 6 per cent. In the Low Wolds potatoes and sugar beet have replaced turnips in the root break, but in the High Wolds the thinner soils are unsuitable to a good crop of either potatoes or beets. The yield of beets is 10 tons per acre in the Low Wolds, but only 5–6 tons per acre in the High Wolds. The High Wolds continue to practise a four-course rotation with little modification, though a little more than half is under corn and a little less than half under roots and seeds.[1] The stock kept are arable sheep, the Lincoln long-wool, and fattening cattle, the Lincoln Red or a cross with the Aberdeen-Angus, but both are declining. Many Wold arable farmers rent acres on Lincoln Marsh for summer grazing of stock to be fattened in the winter in yards or folds.[2]

The Yorkshire Wolds north of the Humber are physically a continuation of the Lincoln Wolds and present a similar type of chalk farming. They are also overlain, in part, by drift. Hall noticed the contrast between the Lincoln and Yorkshire Wolds, on the one hand, and the chalk of the South of England on the other—'less open sheep-walk and more cultivated land right up to the top of the hills'.[3] This is despite the dryness of the Yorkshire Wolds and the liability

[1] Makings summarizes the position thus: 'Although the four-course, based on sheep and barley, has largely failed as an economic farming system on this land under the conditions that have prevailed over the last decade, many poor-wold farmers have kept to it because they have been unable to find a better productive system . . . the breakaway has been largely confined to the better soil regions . . . a position has been reached where two broad types of wold farms may be clearly distinguished: good-wold farms, where cash cropping has been developed, where feeding predominates over rearing in the livestock policy and where mechanization has rapidly advanced: and poor-wold farms, where soil limitations have made effective modifications of the old system impracticable' (S. M. Makings, *Lincoln Wold Farming* (1939), p. 29).

[2] J. Bygott, 'Lincolnshire', in *Great Britain: Essays in Regional Geography*, p. 187.

[3] Hall, *Pilgrimage*, p. 118.

of their villages to suffer severely from drought. The percentage of arable is very high and the Wold has been cultivated as turnip and barley land since the Agrarian Revolution. Although undergoing modification, the Norfolk four-course rotation is still the foundation of Wold arable farming. Wheat, turnips and swedes, barley and rotation grasses, accounted for 78·1 per cent in 1936 of the arable acreage. Oats were substituted for wheat or for barley, and they accounted for an additional 15·4 per cent. Few mangolds or sugar beets or potatoes are grown, but there is a substantial acreage of kale, rape, vetches, and mustard for fodder. The stock on such light land are sheep, and there is still a high sheep density. The cattle density is low and sheep in 1939 constituted the most important animal population. Sheep and barley farming is now unprofitable, but the Yorkshire Wolds have found greater difficulty than the Cotswolds in readapting themselves to new types of farming. The region is too dry for grass dairying and the soil is too thin for market-garden cropping. The arable sheep kept is still the Leicester, but there has been some substitution of down breeds, such as the Suffolk, and of grass breeds such as the Masham.[1]

Sharply contrasted with the Yorkshire Wolds, and indeed with all chalk lands in type of arable farming, are the stiff soils of Holderness. These have still a greater arable than grass acreage, but their cropping system is very different from that of the Wolds. Grain and legumes took up in 1936 no less than 66·6 per cent of the arable, and wheat, beans, and fallow, over half the arable. Very little barley and very few roots were grown. Even the proportion under rotation grass was low (12·6 per cent). 'The main energies of the holdings,' writes Ruston, 'are and always have been concentrated on the production of wheat': this is borne out by the ten-parish sample I took in 1936 whose wheat acreage was 36·7 per cent of the arable, a very high proportion indeed. In 1910 Hall described the Holderness arable rotation as two corn crops followed by a fallow—whether this be bare fallow, seeds, peas, beans, and turnips—and remarked that this was 'really the old English three-field system . . . adapted to modern practice'.[2] Though not strictly true to-day, the system has not been very much modified. Cattle, sheep, and pigs, are all kept. There were in 1936 more feeding cattle than dairy cattle. Among the feeding cattle bullocks over two years old predominate, which is the case only on strong feeding pastures such as the Leicestershire Lias. Elsewhere in England young bullocks, one to two years old, are more common. The reason advanced in Holderness for keeping these older bullocks is 'that the grass is too strong for young cattle'.[3] Precisely the same reason is advanced in Leicester and

[1] A. G. Ruston in 'The Ridings of Yorkshire', *Regional Types of British Agriculture*, ed. by J. P. Maxton (1936), p. 84.

[2] Hall, *Pilgrimage*, p. 116.

[3] Ruston, op. cit., p. 90.

Northampton. The sheep are mainly grass sheep, a flying flock fed on the seeds. The pigs are fed on corn residues. The clays on the inner side of Lincoln Marsh and the clay vale of Lincolnshire, between Lincoln Wold and Lincoln Heath, present essentially similar conditions on their arable land.

Farming in the Fenland is of a highly individualized character.[1] It is specialized and not standard arable cultivation. Cropping is elastic, rotations are not fixed and vary from time to time. There are few stock, and little farmyard manure is made,[2] fertility being drawn from the reserve of humus in the soil and from artificial fertilizers. The region is in itself highly individualized. It is only a few feet above sea-level and is kept free of water only by means of an expensive system of drainage, the drainage rate in 1910 amounting to approximately 10*s*. per acre and in 1941 up to 20*s*. per acre.[3] Apart from roads and bridges, sea-banks and river-banks, the whole area is probably less than 16 feet above sea-level. The higher land is on the belt of light silts lying nearest the sea, and here the surface is slightly undulating. Southwards the inland portions of the Fenland are lower and entirely flat: the soil here is decomposed Fen peat.[4] Fen peat, formed from sedges rather than from sphagnum moss and heath plants, is richer in mineral matter, especially calcium, and is neutral or alkaline, unlike the acid mountain peat.[5] On the inland side of the peat as the land rises is the 'skirt' land, which itself gives way to clay.

The permanent grass is limited to the clay, apart from the paddocks adjacent to the farm buildings and apart from the outwash pastures within the river banks, under water in winter, but providing grazing during the summer months. Over 80 per cent of the area was in arable, according to a sample of parishes in 1936. The precise character of arable cultivation varies to some extent as between silt, peat, and clay, but there are certain features common to a greater or less degree to all soils within the Fenland. Potatoes and wheat

[1] I am indebted to Miss M. Thomas for many of the points in this survey of Fenland farming.

[2] Indeed, it has been said that *peat* soils 'may be injured rather than fertilized by applications of dung and nitrogenous compounds, and consequently a system of farming has been evolved in which livestock plays no part' (Watson and More, op. cit., p. 21). Some of the *silts*, however, were bullock-fattening pastures near Boston before being broken up for arable (C. S. Orwin, *Report of the Third Oxford Farming Conference* (1938), p. 34).

[3] G. Saunders, 'The Claying of Fen Lands', *Journal Ministry of Agriculture*, vol. XLVIII (1941), p. 31.

[4] Cultivation of the peat is drawing upon reserves which are not being wholly replaced and in consequence Hall doubted the longevity of the system (Hall, *Pilgrimage*, p. 76). Of a sample of fifty farmers in the Isle of Ely thirty-eight reported evidence of shrinkage of peat on their holdings (R. McG. Carslaw and P. E. Graves, *Journal Royal Agricultural Society* (1937), p. 39). 'Clay that years ago was 4 feet or more from the surface will now turn up with ordinary ploughing' (Saunders, op. cit., p. 32).

[5] W. G. Ogg, *Chemistry and Industry*, vol. LVIII, no. 16 (1939). The Fenland rivers, moreover, drain chalk and limestone.

are everywhere prominent. In a sample of parishes in Holland these two crops together took up 52·5 per cent of the arable in 1936, and in a sample of parishes in the Isle of Ely, 56·2 per cent. These are both cash crops which give high yields on Fenland soils, higher than in any other district in Britain. Barley is below malting standard, and little is grown. 'In fact in all the produce of the Fens quantity has to make up for lack of quality.'[1] The rest of the arable is under cash crops of various kinds, for few fodder crops are grown. Temporary grass, fodder roots, and green fodder crops, altogether amounted to little more than 5 per cent of the entire arable. Most of the small acreage of turnips is for seed. There are hardly any sheep kept, and but few cattle (these mainly for trampling straw into manure in winter and for grazing on the outwash pastures during the summer) though there are a few specialist dairy farmers for the local milk supply. Pigs were in 1939 fed in substantial numbers on chats and potatoes rejected by the sieve. The cash crops, in addition to wheat and potatoes, include sugar beet, orchard and small fruit, mustard for seed, and market-garden crops of all kinds.

These other crops are more prominent on the silt than on the peat or clay, and on the silt particular localities have particular specialities. The chief district for early potatoes is a coastal strip north-east of Boston: it is a week earlier than any other part of the Fenland.[2] It has light silts, a southern aspect, and the deepest part of the Wash lies offshore. The chief sugar beet district is that around the lower Welland, within 10 miles of Spalding, near which is a sugar beet factory, but sugar beet is grown widely over the Fenland. The chief fruit district is towards the eastern end of the silts around Wisbech: small fruit in the field is here more important than standards in orchards, unlike Kent,[3] the chief small fruit being strawberries, together with raspberries, loganberries, blackberries, and currants. The chief flower and bulb district is in the neighbourhood of Spalding,[4] and the chief district for peas and beans, the silts west of Boston and Spalding. Tomatoes are grown as a summer crop in glasshouses used in winter for bulb flowers. Cabbages are planted on early potato land after the earlies have been lifted, the same practice as is followed in South-west Lancashire. On the peat the cropping system at the time of Hall's *Pilgrimage* was wheat–oats–potatoes,[5] but on the eve of the late war it was wheat–potatoes–sugar beet or oats.[6] According to sample investigations made by the

[1] Hall, *Pilgrimage*, p. 75.

[2] The same fields frequently grow early potatoes year after year (J. C. Wallace, 'Farming in the Holland Division of Lincolnshire,' *Journal Ministry of Agriculture*, vol. LIV (1947)).

[3] The district is locally considered unsuitable for apples.

[4] J. A. Wallace and D. E. Horton, 'The South Lincolnshire Bulb Industry', *Journal Ministry of Agriculture* (1939).

[5] Hall, *Pilgrimage*, p. 74.

[6] Carslaw and Graves, *Journal Royal Agricultural Society* (1937), p. 37.

Cambridge Department of Agriculture, yields per acre on the black fens are roughly one-third greater than in East Anglia as a whole, and farm capital, farm output, and farm employment are each approximately twice as great.[1] The same is true of the silt soils.[2] This high productivity is obtained partly by the natural productiveness of the soil and partly by concentrating on those crops which grow well and give a high cash return.

The clays of West Cambridgeshire and of South Huntingdonshire, on the southern margins of the Fenland, are still largely in arable owing to the difficulty of establishing a good grass sward. Some of these have been farmed successfully on an alternate husbandry system —four years of grass and four years of arable on a rotation of wheat–beans–wheat–wheat.[3] The results of recent grassland research are utilized to establish this four-years ley. The stiff clays are essentially wheat and bean land and about half of the arable is in wheat, beans, and bare fallow. Few roots are grown, though some stock are kept, chiefly cattle and pigs. These are fed on straw, corn residues, and hay, though some of the hay is sold.[4] The wheat acreage increased since the Wheat Act and wheat then provided the largest single element in the gross income of the farm, amounting with wheat deficiency payments to nearly one-third of the whole. The district is, however, not well farmed, some land is derelict in times of low prices, and in 1933 it had a lower gross income per 100 acres even than Breckland.[5] It represents a most striking contrast to the Fenland, which is even more striking when it is remembered that in the Middle Ages the Fenland was largely waste and that the clays then formed the granary of the country. Not unlike these clays of the Oxford Clay Vale, though not quite as stiff and intractable, are the boulder clays of North-west Essex. They may equally well be described as wheat and bean land and, because of the difficulty until recently of laying down to grass clay soils in a dry climate, they are still largely in arable (approximately three-quarters of the farm area in 1936).

In the South-west Peninsula, in the far west of the country physically removed from the English Plain so far considered, is an area not of arable husbandry but of mixed farming. Apart from the moors, the soils are mainly fertile loams and are convertible, capable equally of corn or of grass. The moist climate and the heavy rainfall favour grass, and grass has here a growing season approximately two months longer than that of northern and eastern England. But the

[1] Carslaw and Graves, *Journal Royal Agricultural Society* (1937), pp. 41–3.

[2] R. McG. Carslaw and P. E. Graves, 'Farm Organization of the Silt Soils of Holland, Lincolnshire', *Journal Royal Agricultural Society* (1938), pp. 64–72.

[3] W. S. Mansfield, *Report of Third Oxford Farming Conference* (1938), pp. 38–46

[4] *An Economic Survey of Agriculture in the Eastern Counties*, University of Cambridge, Department of Agriculture, Farm Economics Branch, Report no. 22 (1933), Table 8.

[5] *Economic Survey*, Report no. 22 (1934), Table 3. The fields are very weedy.

climate is also sunny and suitable for corn, it being exceeded in total annual sunshine only by the Sussex and Essex coasts. Devon had in 1939 over one-third of its cultivated land in arable and Cornwall over one-half. In this arable, however, rotation grass figures strongly. In Cornwall it accounted for over half of the arable and in Devon for two-fifths. This is the long ley, an ancient practice adapted to the moist climate and the long growing season; a system known at the end of the eighteenth century as convertible husbandry and to-day as alternate husbandry. The long ley is characteristic of all Cornish rotations and of Devon rotations, except those of East Devon, which in this respect is marginal to the South-west Peninsula proper. Further individuality is given to arable husbandry in the South-west Peninsula by the practice of sowing dredge corn, a mixture of barley and oats, which grow abundantly in the moist climate, and which are used for fodder. The farmers are convinced that a greater weight of fodder can be produced by sowing barley and oats together than by sowing them separately, for they penetrate different layers of the soil and they assist each other to stand up. In most districts of Cornwall dredge corn is the most important single corn crop, but it is of much less importance in Devon. After dredge corn in importance comes oats, a crop obviously adapted to a moist climate. Wheat was of little significance in the 'thirties, even after the Wheat Act. Despite the importance of stock, roots are little grown in Cornwall, but they are less necessary here than elsewhere for winter feeding because of the high grass acreage and the long grazing season. In Devon, however, roots are cultivated extensively. The difference between Cornwall and Devon in this respect is to some extent a relic of the extent of the penetration of the New Husbandry associated with roots, this being more complete in Devon than in Cornwall. The whole of the South-west Peninsula has a high density of stock, as might be expected from its mixed farming and the large acreage devoted to stock foods. Apart from special districts such as West Cornwall, the object of stock farming is the rearing of Devon cattle exported either fat or in store condition. Associated with this distinctive agriculture is a distinctive landscape. Open granite uplands are interspersed amongst the cultivated green landscape, though the uplands have much grass as well as heath and are definitely more grassy than the Millstone Grit parts of the Pennines. The descriptive name 'down' is common on the lower slopes of Dartmoor. The uplands, whether the moors or the cultivated plateau surfaces, are unwooded and only sheltered combes have continuous woodland. In order to provide shelter, the fields, mostly small,[1] are bounded by high walls or banks often surmounted by tall hedgerow

[1] The average size of fields in East Devon was 4 acres in 1836 and 6 acres in 1905 as compared with 30 acres in western East Anglia (W. H. Long, *The Farm Economist*, vol. 1 (1933–5), pp. 224–5; and R. McG. Carslaw, *The Farm Economist*, vol. 1 (1933–5), pp. 36–7.

timber. The roads in consequence are narrow and deeply incised, with sudden changes of gradient due to the accidented plateau surface of the country.

The most highly individualized district is West Cornwall, having the most equable climate of all. This is the district of early vegetables and flowers, and the dominant breed of cattle is the Guernsey, all features indicative of a mild climate. It is, in fact, the most southerly as well as the most westerly part of England. Holdings are small and the land is intensively worked. The market-gardening is limited to the land around the bays close to the sea, where the equability of climate is at its maximum. The object of the farming on the land removed from the sea is the dairy and crops are grown with this end in view. There are thus two forms of land utilization in the district. In a sample of ten parishes for 1936 the arable took up 64·2 per cent of the cultivated land and the permanent grass 35·8 per cent; but much of what is returned to the Ministry as permanent grass is, in fact, the last years of a long ley.

On the land not devoted to market-gardening the usual rotation is three years' cropping with a ley of three to five years. Of the three years' cropping two are under corn, mainly dredge corn and oats, with a break devoted to roots, bare fallow, and some market-garden crops. Most of the crops, as well as the grass, are fed to the dairy herd. The cattle density is high.[1] West Cornwall is distant from the urban milk market, even the highly organized London market. The milk from the Guernsey is high in butter fat, and the fat globules are of the kind suitable for butter-making.[2] Butter-making was, in fact, the prime object of dairying in West Cornwall, until it was invaded by the liquid milk market in 1937. The separated milk is fed to pigs and the pig density was high—in the 'thirties three times as high as that of England as a whole. The density of fowls was also above the average, and the egg business is carefully organized for export to consuming centres in Britain. There are few sheep. In its dairy cows, pigs, and poultry, it presents many of the characteristics of a dairying region.

The market-garden land close to the sea, like most high-yielding market-garden soils, is heavily manured. Penzance and Gulval are

[1] It must be remembered in qualification that the Guernsey breed is a comparatively small one with a comparatively small yield of milk, and that its food requirements are in consequence much below those of the larger dairy breeds dominant in other districts. A larger number of cows can be kept, therefore, for a given quantity of food.

[2] The process of butter-making consists of clumping together the fat globules, and the larger the globules initially the more easily will this be accomplished. The fat globules of the Guernsey are relatively large, much larger than the fat globules of the Ayrshire, Shorthorn, and Friesian. Summer-produced butter is yellower and higher in vitamins A and D than butter produced in winter; for reasons of nutrition as well as of cost, butter is most satisfactorily made in summer.

its centres. It has a favourable climate and a favourable deep loam soil, whose fertility is maintained by sea-sand and seaweed. Proximity to the sea is thus of advantage in obtaining manure as well as in securing equability of climate. Most of this land bears a crop of broccoli,[1] cut between Christmas and the end of February, and in addition a crop of early potatoes, set in late February or early March and lifted in May. This double cropping has been followed on some land without break, but on other land other market-garden crops, and even corn, followed by clover, are sown to give the land a change. High rents, however, act as a deterrent to laying down land to grass for a rest. This market-gardening had to face foreign competition, Italian broccoli being imported in large quantities as early as November. Early potatoes have suffered more from foreign competition and flowers were being substituted for them until the Import Duties Act gave some degree of protection, and in consequence early potato growing increased again. There is some fruit, but the moist climate encourages fungoid diseases[2] and is not generally suitable except perhaps for early fruit, encouraged by the early summer. It is, in fact, the mild winter and the early spring and summer which constitute the chief environmental advantages of West Cornwall. It must of necessity, however, produce for a distant market, and in order to reach this market as quickly as possible marketing and transport have been elaborately organized. This is facilitated by the circumstance that the main line of the former Great Western Railway runs alongside the market-gardens.

Arable farming in Wales is everywhere subordinate to grass, and stock are the main object of husbandry. But there are few districts having continuous stretches of permanent grass, the nearest approaches being the Vale of Carmarthen, the Vale of Glamorgan, and the lowlands of Monmouth. The more usual system of farming is that of the long ley, somewhat similar to that of the South-west Peninsula. Most farms have some fields of permanent grass, but the rest of the farm is ploughed at intervals, cropped for a few years, and then laid down again to grass. But, while in Cornwall half of the improved land is returned as arable, in Wales as a whole that returned as arable is less than one-quarter. This long ley arable system is the modern form of an ancient practice and an adaptation to the moist wet climate under which conditions the quality of grass tends to deteriorate. It is facilitated by the light character of most Welsh coastal and lowland soils and the consequent ease of ploughing. The object of arable farming is thus, in part, the renovation of the grassland and, in part, the growth of food for stock. Very little of the arable produce is sold off the farm: 'the net sales of crops do not

[1] J. J. MacGregor, 'Production of Broccoli in West Cornwall', *Journal Ministry of Agriculture*, vol. XLIV (1937), p. 848.

[2] Hall, *Pilgrimage*, pp. 344–5.

exceed 5 per cent of the total farm sales'.[1] It is a system which fits into the stock husbandry. Rotation grasses take up nearly half the arable, presumably the first years of a long ley; of the corn crops the most important is oats, but a fair amount of feeding barley and of mixed corn are also grown; of the roots the most important are turnips, swedes, and mangolds.

The crops grown are not everywhere the same. The most striking contrasts are between the counties of the Welsh Border in the lee of the Welsh Upland and the coastlands of West Wales to the windward of it. Along the Welsh Border arable farming approximates to the model of the English Plain—corn is relatively more important and grasses in rotation relatively less important, wheat becomes a significant crop and orchards a significant part of the landscape. In this there can be traced alike the drier sunnier climate of the Welsh Border and the practices of the English Plain. Most of the heavy land is now in permanent grass, and along the Welsh Border it is chiefly the light soils that are in arable. The north-western counties of Anglesey and Carnarvon are sharply contrasted. Rotation grasses during the 'thirties took up well over half of the total arable and corn crops well under a third; wheat and orchards are almost entirely absent. This not only reflects the wetter, cloudier climate, but also the persistence of practices common to the whole western seaboard. The proportion of the improved land that is in arable is usually greater in West Wales than along the Welsh Border, despite the heavier rainfall of the former. It is greatest of all in the western peninsulas—Anglesey, Lleyn, and Pembroke. These are exposed to winds from off the sea and are practically treeless except in sheltered hollows, but they are traversed by broad banks similar to those of the South-west Peninsula, banks which give shelter to crop and beast. Around the shores of Cardigan Bay barley is a relatively more important crop than elsewhere, but it is grown for feeding and not for malting. At the time of Sir Daniel Hall's *Pilgrimage* the barley seed sown was of indigenous strains.[2] Welsh barley straw is even better for feeding purposes than is normally the case with barley straw elsewhere, and it has also a good deal of bottom growth of grasses and clovers, for barley is a common nurse-crop for seeds prior to a long ley.[3] Everywhere, however, except in Monmouth, oats is the chief corn. White oats are usually grown on the warmer lowland farms, but many upland farms grow black and yellow varieties which are hardier and can withstand poor soil and

[1] A. W. Ashby and E. Ll. Harry, in *Regional Types of British Agriculture*, ed. by J. P. Maxton (1936), p. 230. On a sample of fifty-six farms in 1937–8, 3·0 per cent of the total receipts were from crops, and in 1936–7 2·4 per cent (J. Pryse Howell, 'Financial Results . . . of Farms in Wales', *Welsh Journal of Agriculture*, vol. XV (1939), p. 77).

[2] Hall, *Pilgrimage*, pp. 328–9.

[3] T. W. Fagan and J. E. Watkin, 'The Chemical Composition of Barley Grain and Straw grown in Mid-Wales', *Welsh Journal of Agriculture*, vol. VI (1930).

heavy rainfall. Under lowland conditions in North Wales the white varieties yield more grain, the black and yellow varieties more straw.[1] But on land of low productivity the hardier varieties are the more productive.[2]

In the West Midlands two sample areas only will be considered—the Vale of Evesham and the Plain of Hereford.

The Lias Clay Vale, from Lincoln to Gloucester, is mostly in grass (apart from the Marlstone ridges within it), but in the Vale of Evesham it is in arable. In the centre of the Vale 61 per cent of the cultivated land was in 1936 under arable management, largely for specialist vegetable and fruit culture. The Lias is here overlain, but not buried, by outwash fluvio-glacial material, much of which has subsequently been reworked by river action. This cover has been incorporated by cultivation into the underlying clay. The most important fruit and vegetable soils are the Evesham and Haselor series, derived mainly from the Lower Lias, and the Pershore and Badsey series, derived from river terraces and brick earths.[3] The lighter shallower soils do not carry standard fruit-trees successfully. Whether the Vale of Evesham possesses any particular climatic qualities is uncertain, but the Vale has an economic asset for fruit cultivation in the Evesham Custom, which ensures the benefits of improvements to the tenants. In the Vale of Evesham about three-quarters of the arable in the 'thirties was in fruit and market-garden crops. Much of the cultivation is by small-holders who cultivate market-garden crops and small fruit beneath plum standards, but there are a number of new plum plantations mostly on the margins of the district which have little or no inter-cropping beneath them.[4] The small fruit are mainly currants, gooseberries, and strawberries, but of vegetable crops there is immense variety—cabbages, cauliflowers, brussels sprouts, green peas and green beans, salad vegetables, asparagus, carrots, celery, rhubarb, leeks, onions. Some of these are adapted to light and others to heavy soils: early peas do best in light soils and maincrop peas in heavy soils, for example. The district has an aspect of bustle and intense activity. Situated in the geometrical centre of England, the Vale of Evesham is well placed for the

[1] R. Alun Roberts, 'The Significance of Variety in Oats', *Welsh Journal of Agriculture*, vol. IV (1928), pp. 157–70.

Averages for 1903–26	*White*	*Yellow*	*Black*
Grain in bushels per acre	72	68	66
Straw in cwt. per acre	38	39	41

[2] 'Thus varieties of Record type (white) are superior in yield to varieties like Black Bell III (black) . . . at productivity levels of 20 cwt. of grain per acre and upwards, but are superseded by the latter at lower levels of productiveness. These in turn are superseded by varieties like Ceirch Llwyd when the comparisons are made at the lowest cultivated levels of productivity.' (*Reports on the Work of Agricultural Research Institutes, 1934–5* (1937), p. 27).

[3] T. Wallace, 'A Survey of Soils and Fruit in the Vale of Evesham', *Journal of the Bath and West and Southern Counties Society*, Sixth Series, vol. XI (1936–7).

[4] E. W. Hobbis, 'The Plum Plantations of Worcestershire', *Journal Ministry of Agriculture*, vol. XLVI (1939), pp. 339–40.

distribution of its crops, and this is made effective by a well-organized rail service.

The Plain of Hereford constitutes an area of mixed farming[1] with grass dominant before 1939. The soils vary from the light loams of the Ryelands in south Herefordshire to the heavier soils of the Lugg Valley, a green sward of fatting pastures. The grass here is of such a quality that fattening cattle are allowed on it for only part of the day at a time. The rainfall is relatively low as the Plain is in the rain shadow of the Welsh Upland, and there is frequently a lack of moisture on the light lands. The object of farming comprises both crops and stock. The arable is either on the higher land, the steep valley sides being in pasture, or on the gravel stretches constituting glacial outwash. In the Ryelands the arable cultivation is of a turnip and barley type, and in the Bromyard Highlands, where the soil is heavier, there are hop-yards and orchards in substantial numbers, in addition to mixed farming. The 'silty loams' of the Bromyard Highlands[2] are suited to hops and these, together with the adjoining Teme Valley of West Worcestershire, is the most important hop district outside South-east England.[3] The fruit is partly of standards in grass orchards and partly of standards in arable orchards with bush fruit below. The grass orchards are the type traditional to the West Country and the arable orchards are a more modern introduction. The standard of orcharding and productivity of the trees has improved in recent years.[4] The stock kept in the Plain of Hereford are both cattle and sheep. The white-faced Hereford is a small-boned feeding animal. Some are fattened in the Plain either in the Lugg Valley on fatting pastures in summer or in the Ryelands in the yard in winter, and some are exported as stores for finishing on the fatting pastures of the East Midlands. Sheep are most prominent on the turnip and barley soils of the Ryelands and the local breed (the Ryeland) takes its name from the district.

South-west Lancashire forms a sharply defined and intensively cultivated arable region set in a western district and physically removed from all other arable regions, even more completely than is the South-west Peninsula. It coincides with an area of light soils and of low rainfall. In South-west Lancashire the boulder clay, largely derived from the Trias, is overlaid by the post-glacial Shirdley

[1] A sample of thirty-two farms for the 1945 crop year had 46 per cent of 'production' from live stock and 54 per cent from crops. Live stock production included milk, live cattle and live sheep, and crop production, grain, roots and fruit. I am indebted to Dr. C. V. Dawe for these returns.

[2] T. Wallace, G. T. Spinks, and E. Ball, *Fruit Growing Areas on the Old Red Sandstone in the West Midlands.* Ministry of Agriculture, Bulletin 15 (1931).

[3] In the spring of 1945 of 968 hop growers in England, Hereford had 217, Worcester 81 and Kent 545 (*Hops* (1947), Table 9).

[4] C. Savidge, 'Cider Orcharding in Herefordshire', *Journal Ministry of Agriculture*, vol. XLI (1935).

Hill Sand and by post-glacial peats accumulated on the flats. The Shirdley Hill Sand yields a light easily worked soil which warms up quickly in the spring and is eminently suited to arable cultivation. The drained peat is very similar in composition to the drained peat of the Fenland, is equally suited to arable management, and yields similarly heavy crops. Being in the rain shadow behind North Wales, the area has a low rainfall of approximately 30 inches, and it is sunnier and warmer than the grass districts to the north and east. Where the Shirdley Hill Sand and the peat soils are replaced by heavy boulder clays and where rainfall increases eastwards with approach to the Pennines or Rossendale, the arable dies away, in places suddenly and sharply.[1] But it extends a long tongue eastwards as far as the western outskirts of Manchester-Salford, where moss soils are still to be found and where the rainfall remains low.

The whole region is almost entirely arable. Apart from a few suburban dairy farms on the margins of the built-up area of Liverpool, the only grass fields are small paddocks adjacent to the farmstead. Hardly any stock are kept except a cow or two, and the farm horses required for the work of the farm. Being an entirely arable system and the land being intensively cultivated, there is a good deal of elasticity in rotation. The object is to grow crops for sale, and other crops are introduced largely in order to keep the land in good heart. Temporary grass is grown to give the land a rest, but practically all the hay (as well as the straw) used to be sold off the farm. The town dairies and the town stables of Liverpool once provided a large market for such hay, but with the decrease in urban cow-keeping and with the substitution of mechanical for horse transport this market has declined, even though heavy dray-horses are still used extensively about the docks. Several farmers, faced with this decline in the market for hay, have grazed their seeds at one time with fattening bullocks and later with dairy cows.[2] The most profitable crop is potatoes, earlies on light dry soils[3] and main crop elsewhere. They have been grown too frequently on some farms, especially during the war of 1914–18, and eel-worm resulted; potatoes are therefore now rarely grown oftener than every third year. The cereals are wheat and oats—oats because of the urban demand for horse feed and wheat especially since the Wheat Act. A common rotation is potatoes–oats–seeds (one year),[4] another, potatoes–wheat–oats–seeds (one or two years), a third, potatoes–wheat–seeds (one year)–oats; but almost endless variation is to be

[1] J. A. Taylor, 'An Agricultural Borderland in South-west Lancashire', *Geography*, vol. xxxv (1950).

[2] Many others graze a flying flock of grass sheep in the autumn.

[3] The slopes favoured for earlies are those facing south, for obvious reasons, and those facing north, for reasons not immediately obvious. Early potatoes are liable to damage from frost, thawing suddenly in the morning sun: a northward slope escapes this *sudden* thawing.

[4] H. King, 'Lancastria', *Great Britain: Essays in Regional Geography*, ed. by A. G. Ogilvie, p. 281.

found.[1] Cabbages, both spring cabbage and summer cabbage, provide another cash crop which is occasionally very lucrative when crops in southern England fail through frost or drought. A crop recently added, in the Cronton, Rainford and Bickerstaffe districts, is peas for canning. In addition to this specialist field cultivation, there is also on certain black moss soils in close proximity to urban areas—to Southport, Manchester, or Preston—specialist market-gardening on small-holdings. Some of these, particularly on Chat Moss and the tiny Ashton Moss, are celery farms; others are market-gardens with a wide range of crops—cabbages, cauliflowers, peas, salad vegetables—and these often have in addition a small acreage under glass with tomatoes in summer, chrysanthemums in winter, and lettuce in spring. There is also a patch of bulb-flower cultivation at Hale, with a southern aspect overlooking the Mersey estuary. There are thus many points of similarity with the Fenland. As the intensely cultivated arable farms of South-west Lancashire have virtually no stock, the problem of maintaining fertility involves very considerable expense in buying in manures and fertilizers. Manure from Liverpool dairies and stables is carried back to the farms, but this supply is diminishing, and dung is now being bought in increasingly from grass-dairying districts to the east and north. Many farmers' leases, however, prohibit dung to be sold off the farm, though it is certain that many grass dairy farms produce considerably more dung in winter than their meadows require.[2]

Flanking this predominantly arable district of South-west Lancashire, both to north and to south, are districts which, though mainly in grass, have some arable. In North Cheshire there are light sandy loams interspersed with heavier loams; the heavier soils are in grass and grazed by dairy cattle, but the lighter are cultivated on a rotation of potatoes–wheat–oats–seeds (one or two years). In the Fylde to the north of the Ribble, only the mossland and the moss overlain with a thin film of sand (the inland margin of the blown sand along the coast) are in arable cultivation. The arable amounted in 1934 to 21·1 per cent of the total improved land. The percentage of corn grown was low (39·6 per cent of the arable), of seeds and of fallow crops high. The rotation is a four-course or some variant of it (corn–roots–corn–seeds); it is often lengthened by leaving the seeds down for two or three years, and it is sometimes shortened to a three-course in order to crop potatoes as often as possible. Oats are grown more frequently than wheat, but wheat increased greatly after the Wheat Act. The produce of about half the arable is sold and the rest fed to stock.[3]

[1] Replies to a questionnaire exhibit several examples of each of these rotations.

[2] In addition to help received from many farmers, I am indebted to H. King and J. F. Maguire for some of the points in this paragraph. See also W. Smith in *The Land of Britain*, ed. by L. D. Stamp, pt. 45, *Lancashire* (1941).

[3] W. Smith, 'The Agricultural Geography of the Fylde', *Geography*, vol. XXII (1937), pp. 5–6.

III

REGIONAL VARIETIES OF ARABLE HUSBANDRY: SCOTLAND

In the Merse of Berwick and the Milfield Plain, in northern Northumberland, the system of arable husbandry is transitional between that of eastern England and that of eastern Scotland. The soil in the Merse is derived from drift, arranged in parallel drumlins, overlying Calciferous Sandstone (of Carboniferous age) and Old Red Sandstone; the Milfield Plain is a drained lake floor.[1] The heavier land near the Tweed has been reclaimed from bog only comparatively recently, and it is not as good land as the drumlin country.[2] Rainfall is relatively low and the area is essentially turnip and barley land. Prior to 1914 it was managed on a four-course system: roots–barley–seeds–oats.[3] This was similar to much eastern England arable farming, except for the sowing of oats in place of wheat, a change indicative of lower temperatures and of lesser sunshine. The region has, in fact, lower summer temperatures than the Lothians, owing to the frequency of sea mists driven inland. Cool summers, however, though they do not favour wheat, do favour heavy crops of roots. During the inter-war period the four-course was modified by leaving the rotation grass down for two or three years; in other words, by the practice of the long ley typical of Scotland and of western England, but unusual in eastern England. The land is held to be too light to permit good permanent grass: 'after eight years or so the pasture is definitely on the decline, as on Tweedside land it is extremely difficult, even under the best management, to keep out Yorkshire fog'.[4] The roots now include some sugar beet and some potatoes, which serve as cash crops in addition to barley and wheat, the acreage of the latter having increased since the Wheat Act. These are the only crops sold. The rest are fed to stock, both cattle and sheep. Some cattle are reared, but it is fattening of imported stores which is the chief objective of cattle husbandry, fattening not only in yards in winter, but also, with the increase in the acreage under seeds, on grass in summer. Nevertheless, it is sheep that are the dominant stock, a predominance due doubtless to the proximity of the sheep husbandry of the Southern Uplands and to the character of the turnip and barley soils, naturally sound for sheep. The ewes

[1] Only a small proportion of the improved land exhibits any degree of soil acidity. A field to field acidity survey made in 1927 of a parish in the Berwick lowland gave 39·2 per cent of the acreage with a pH of 7 and over and only 3·3 per cent strongly acid with a pH of under 5·5 (W. G. Ogg and W. T. Dow, 'An Acidity Survey . . . in Berwickshire', *Scottish Journal of Agriculture*, vol. XI (1928), p. 276).

[2] *The Profitableness of Farming in Scotland: Report for 1928–9* (1931), p. 136.

[3] J. A. Hanley, A. L. Boyd and W. Williamson, *An Agricultural Survey of the Northern Province* (1936), p. 24.

[4] A. R. Wannop, 'The Agriculture of Northumberland', *Agricultural Progress*, vol. XIII (1936), p. 48.

are the Half-bred (Border Leicester × Cheviot) and the main objects of management are, firstly, fat lambs from the Half-bred ewes by Suffolk or Oxford Down rams,[1] and, secondly, fat hoggs fed on roots and seeds. 'The summer stocking of most of the temporary leys is very heavy, many fields being able to carry one ewe with twin lambs and almost one fattening bullock per acre.'[2] A good deal of this sheep farming is, therefore, on grass, as it is increasingly in the Western Downlands. But, although Merse farming is thus different in detail from eastern England arable farming, and although it approximates to practices in Scotland, the Scottish system is not fully developed. The farm buildings, with their substantial houses and their farm chimneys, are, however, essentially comparable to the Scottish steading.

The most famous arable district in Scotland is the Lothians. A narrow strip along the shore near Dunbar was described by Sir Daniel Hall as 'without doubt the most highly-farmed district in Britain—indeed, in the whole world'. The soils are light drift, largely derived from the Carboniferous and from the Old Red Sandstone.[3] The climate is dry and relatively cool as compared with southern England, but, together with Fife, Perth, and Angus, it constitutes the sunniest part of Scotland,[4] and has in fact the highest yield per acre of wheat, barley, and oats in Scotland.[5] It has also the highest yield per acre of hay from temporary grass, but a lower yield of hay from permanent grass than many other Scottish districts. It is surpassed in yield of potatoes and equalled in yield of turnips and swedes by several western and northern Scottish counties. The Lothians are, therefore, the most favoured part of Scotland for corn growing, but no better than many other districts for roots and grass.

Being intensively cultivated, the land is very largely in arable, and as many sale crops as possible are grown. The common East Lothian rotation is a six-course, roots or seeds alternating with corn—potatoes–wheat–turnips–barley–seeds–oats,[6] giving four saleable crops out of six. But there are almost endless variations on this general theme. On the Dunbar red soils potatoes are taken oftener in the rotation, every third instead of every sixth year. The rotation is thus potatoes–wheat–seeds–potatoes–turnips–barley,[7] which again gives four saleable crops out of six. Under both rotations, apart

[1] The Half-bred ewe has a high lambing percentage, in the Merse as high as 1·6 to 1·7 lambs per ewe.

[2] Wannop, op. cit. p. 49.

[3] Dr. W. G. Ogg gives the following pH values for the surface layers of cultivated soils: podsol on Old Red Sandstone, 5·6; podsol on Coal Measures, 5·2; brown earth on Old Red Sandstone; 6.3; brown earth on Carboniferous Limestone, 7.7 (*Guide Book: Third International Congress of Soil Science* (1935)).

[4] *Averages of Bright Sunshine for the British Isles for periods ending 1935*, M.O. 408 (1936).

[5] That is, ignoring the yield in those counties with small acreages.

[6] White, *Rotation of Crops*, pp. 18–19.

[7] Hall, *Pilgrimage*, p. 134; White, op. cit., p. 19.

beet; turnips and swedes are the most important roots, and they have a high yield in the cool climate. Rye grass and clover are sown and left down as a long ley. The cropping is thus essentially simple and limited: oats–oats–turnips–barley–seeds (for three years) or oats–turnips–oats–seeds (for three years) being the common rotations. Practically the only saleable crop is oats, but this is of fine quality and sold for milling.[1] For the rest, the crops are all for fodder. As the permanent grass is so limited, the rotation grass is grazed and hay is normally taken from the first year seeds alone. The stock kept are both cattle and sheep. The cattle are, in part, bred on the arable farms, but are mostly bought in from hill-farms within the county in the case of the Aberdeen-Angus, or from Ireland in the case of those of a Shorthorn type. A number of farms near Aberdeen keep a Shorthorn dairy herd, but it is only in this district that dairy cattle approach feeding cattle in numbers. The feeding cattle are finished both in winter off crops and in summer off grass, grass feeding having increased relatively in recent years. The product is prime Scotch beef, sent largely to London. Sheep are now kept in considerable numbers on most arable farms, though not on all; they are partly stores bought in for winter fattening and partly ewes for fat lamb production. Pigs and poultry had increased by 1939, but their density was still comparatively low. It is cattle that are the chief objective and they bring in half, or over half, of the gross receipts. The proportion of receipts from crops has increased a little and from cattle declined a little since 1939.

The Moray Firth coast is different from lowland Aberdeenshire in only relatively minor features, but these are of some significance. The bed-rock is the Old Red Sandstone instead of granite and the drift, in so far as it is derived locally, forms the parent-material for somewhat better soils. The lowlands of Nairn and Moray were important grain-growing districts prior to the eighteenth century and had a surplus of grain for the population of the Highland glens when the glen harvest failed. The rainfall is a little lower than in Aberdeen and the district has a reputation of greater warmth and a less bleak climate. Nairn has higher monthly maximum temperatures than Aberdeen, but lower minimum temperatures; the Moray coast is, therefore, warmer during the day.[2] The coastal lowlands, removed from the sand-dune belt fringing the actual coastline, had over 90 per cent of its improved land in arable. This is cultivated on lines very similar to Aberdeenshire, but wheat reappears and barley is relatively more important, both results of the more kindly day-time climate. Relatively fewer oats are grown, but the proportion

[1] Crops constituted in 1932–3 less than 15 per cent of gross receipts in the 'North-east Area,' *Fifth Report on Profitableness* (1935), p. 18.

[2] *Averages of Temperature for periods ending 1935*, M.O. 407 (1936). The difference is most pronounced in spring.

of the arable under corn is higher than in Aberdeen. The length of the ley is correspondingly shorter.

In western Scotland, north of the Highland Line, there is little arable cultivation, and there are no arable *regions* of any substantial dimensions. There are, however, in this broken country patches and strips of arable land. Two examples of these will be considered—the crofter settlements of the western seaboard and islands, and, secondly, the potato lands of the Ayrshire coast.

The crofter settlements are invariably small and discontinuous, and they present many features similar to the farm villages of West Norway in a comparable type of terrain. There is, indeed, much community of blood as well as comparability of economy and of terrain between the north-western seaboard of Scotland and West Norway. These crofter settlements are small and discontinuous because of the discontinuity of land capable of cultivation in the prevailing expanse of bog and moor: the discontinuous patches comprise alluvial flats at the heads of lochs, raised beaches, present-day beaches along whose inner margin sea-sand mixed with broken shell ameliorates the acidity of the ubiquitous peat, and, occasionally, though the land is here of poorer quality, dry patches along the cliff-tops. In the Alps the southward-facing slopes carry the settlements and most of the improved land owing to greater sunshine, the northward-facing slopes being longer in shade. But in Scotland the same limitation of settlement and of improved land does not obtain, for northward-facing slopes in a high latitude may have a longer duration (though lesser intensity) of sunlight and diffused light than southward-facing slopes. Degree of slope and general position relative to neighbouring heights is here as important as aspect.[1] The same is true of Norwegian fiords as of Scottish glens. The usual crofter's holding is one to five acres of improved land with a share in a common hill grazing. The improved land is immediately adjacent to the homestead and is usually in arable cultivation, growing oats, barley, potatoes, temporary grass, some turnips, and some cabbages. The barley is commonly limited to the areas of drier sandy soil, such as the machair lands of western Lewis. Turnips are uncommon on the crofts and they are usually grown only on farms with a substantial sheep flock. Crofting is farming at a low level of comfort,[2] stock are sold and a subsidiary income is provided by fishing[3] or by work on the roads. or by summer-time

[1] A. Garnett, *Isolation and Relief* (1937), and 'Diffused Light and Sunlight in relation to Relief and Settlement in High Latitudes', *Scottish Geographical Magazine*, vol. LV (1939)

[2] For advice to the crofter on improvements and for excellent photographs of Highland crofts, see F. Fraser Darling, *Crofting Agriculture* (1945).

[3] In an investigation into diets in Lewis and mainland crofting communities it was found that all families in Lewis ate fresh fish, but that only twenty-six out of forty-four families sampled on the mainland ate fresh fish in summer and only twenty out of forty-four in winter. Even with these crofting communities living

employment in the deer forests. The potatoes are consumed by the human population,[1] the oats, turnips and hay by the animal population. Stock have access to the stubble in winter, but in summer are pastured on the moor, now the hill grazings adjacent to the crofts but formerly distant shielings to which part of the population used to move temporarily. The stock kept are cattle and sheep, but there are also big sheep flocks tended by shepherds on mountain sheep walks, following quite a different farming system to the crofters.[2]

The specialist potato cultivation of the Ayrshire coast is also a function of coastal sands. The cultivated land is often fringed on the seaward side by golf links, and these in turn by sand-dunes. Light and easy to cultivate and warming up quickly in the spring, these soils are essentially suited to early potatoes. The climate is equally favourable, for the shore is washed by a branch of the Gulf Stream drift, and in many places is backed by cliffs giving shelter from east winds: winter and spring are consequently mild and relatively free from frost. First earlies are grown at the northern and southern end of this belt where the coastal strip is sheltered, while the middle part grows second earlies and main crop potatoes.[3] Much of the favoured land grows potatoes year after year, fertility being maintained by farmyard manure, by seaweed, by artificials, and by ploughing in catch crops sown after the potatoes have been lifted. These catch crops are very varied—rye grass, kale, even barley—and they are sometimes grazed or cut and the stubble ploughed under. Some difficulty is experienced in obtaining sufficient farmyard manure, and many farmers, having arable land behind the coastal sands, buy in bullocks to make the manure required, while others buy in dung from as far afield as Glasgow. There is somewhat similar early potato cultivation on raised beaches in Wigtonshire with a southerly aspect: soil and climate are again favourable.

IV

TYPES OF ARABLE HUSBANDRY: SUMMARY

Thus varied is the regional pattern of British arable farming. It is indeed so varied that it is difficult to summarize adequately its main features.

The largest distinction is between the English and the Scottish

a hard life in a hard environment the standard of diet was better than in urban communities in St. Andrews, Cardiff, and Reading (E. P. Cathcart, A. M. T. Murray, and J. B. Beveridge, *Medical Research Council,* Special Report No. 242 (1940).

[1] Imported meal has replaced local-grown oats for human food. The same change is taking place in West Norway, flour being one of the staple cargoes of fiord steamers.

[2] A. T. A. Learmonth, 'The Population of Skye', *Scottish Geographical Magazine,* vol. LXVI. no. 2 (1950).

[3] J. H. G. Lebon in *The Land of Britain,* pt. 1, *Ayrshire* (1937), p. 48.

arable districts, a distinction which is almost entirely a function of climate in respect of the general contrast between English and Scottish practice. Eastern Scotland has cooler and less sunny summers than the English Plain. This is shown clearly by a study of accumulated temperatures calculated within the growing season of wheat.[1] Using Rothamsted records, Curtis estimated that wheat required 1,961 day-degrees F. with a deviation of ±8 per cent. The whole of the English Plain has accumulated temperatures of over 1,800 day-degrees F., but they fall below this level in upland Wales, in the Pennine upland, in parts of North-east England, and in Tweeddale. They rise above 1,800 day-degrees F. again in the Lothians and in the eastern Central Lowlands of Scotland generally, but they fall in Aberdeen, and, although they are slightly higher along the Moray coast than in Buchan, they remain below this level.[2] Even in the most favoured districts of Scotland wheat is rarely the most important farm crop, and in some important arable districts such as Buchan it is almost entirely absent. Among the roots, mangolds and sugar beet, which require sunshine, are of as little importance as wheat. Scottish arable farming, therefore, has a more restricted range of crops than English arable farming. Scottish arable farming also is closely associated with stock and with stock feeding, a product partly of the cooler climate (for it is the fodder crops which grow most successfully) and partly of the pastoral tradition of the country. Though these features are present in all Scottish arable farming with the exception of specialist early potato growing, there are regional differences of emphasis. The sunnier and warmer districts have a more varied range of cropping and a greater proportion of crops for sale. It also happens that the Lothians, where these divergencies are most pronounced, are in proximity to the major markets of the country. Climatic and economic factors thus coincide. In the more remote districts few crops are sold and, as in Caithness, not even stock fattening is the objective, but stock rearing.

Within South Britain there are major distinctions due to climate and to soil. There is a contrast between eastern arable farming and western arable farming in accordance with the contrast in climate. In dry eastern districts it was until recently difficult to establish a good grass sward. In the arable of the eastern counties rotation

[1] Accumulated temperatures refer to the number of day-degrees above the base of 42° F., the minimum temperature for germination. Average regional dates of sowing and of harvesting have been kindly supplied by the Ministry of Agriculture and the accumulated temperatures of each region have been worked out within the growing period of that region. I am indebted to T. H. King for these calculations.

[2] Miss Snodgrass states that wheat is grown in Scotland where accumulated temperatures range from 1,600 to 1,750 day-degrees F. Her calculations, however, ignore September, which, in the case of the Lothians, with harvest on September 16 on the average, adds some 200 day-degrees F. (C. P. Snodgrass, 'Influence of Physical Environment on the Principal Cultivated Crops of Scotland', *Scottish Geographical Magazine*, vol. XLVIII (1932), p. 333).

grass thus forms only a minor element, in some districts under 10 per cent of the arable. The lowest proportion of all is in areas of very light soil, such as Breckland and the Sandlings of East Suffolk. Rye grass is not successful on poor light land. In contrast to the small acreage of rotation grass in eastern districts is the extensive acreage in western districts in the form of the long ley, land left down to grass for three to five years. The moist climate facilitates the 'take' of seeds and the growth of grass and, where long ley farming is well developed, rotation grass may take up over half the entire arable. Parallel with the long ley is a lesser acreage under wheat and barley than in eastern districts and a greater emphasis on oats and, in the South-west Peninsula, on dredge corn. This again is an adaptation to climate. Eastern arable farming, where not specialist fruit growing or market gardening, is usually associated with winter fattening of stock. Western arable farming, on the other hand, with ample summer grazing, is associated with stock in summer as well as in winter, indeed, even more than in winter.

Within South Britain there are also sharply defined contrasts between systems of arable on different types of soil. Arable farming on chalk and on clay are entirely different; the one is based on the New Husbandry with subsequent modifications largely in the nature of substitution of crops, the other affording relics, more or less disguised, of the old medieval husbandry of the three-field system. The one is turnip and barley land, the other wheat and bean land. As so much of the English Plain is of chalk and of clay, the two types of farming are frequently in close juxtaposition—as the Yorkshire Wolds and Holderness, Lincoln Wold and the clay Vale of Mid-Lincoln, the Cambridge chalk and the Cambridge–Huntingdon clay, the Wiltshire chalk and the Vale of North Wiltshire. Chalk farming differs according to whether the chalk is covered with drift or is free from drift. There is more rough grazing on the down summits of the drift-free chalk and a rather more extended keeping of grass sheep, while there is less substitution of sale crops such as sugar beet for fodder crops such as turnips on their thin soils. On the drift-covered chalk the land is under the plough to the summit of the hills and the greater depth of soil allows greater variety of cropping. There are other types of arable farming in the English Plain in addition to those on chalk and clay. Brick earths, valley gravels, and light loams in sunny southern England, whenever they are suitably placed for markets, are frequently in a specialist fruit or market-gardening culture: they respond to manuring, they are warm early soils and the brick earths are naturally fertile. The lowland fen and moss soils are cultivated in an intensive round of cash cropping, an intensive cultivation made possible by their inherent fertility. Together with the Fenland silts, the Humber warp, and the light warm loams of South-west Lancashire and the Lothians, they

are the most productive land in the whole country. These highly fertile brick earths, mosses, and silts, are all specialist cropping soils with scarcely any stock. They are thus sharply distinguished from chalk and heavy clay arable farming, from most Scottish systems, and from the long ley arable husbandry of western Britain alike.

CHAPTER V

GRASS FARMING

I

TYPES OF GRASSLAND

GRASS farming in Great Britain presents no less variety than arable farming. Grassland varies greatly in quality and in capability. The best fatting pastures can fatten a bullock and one or two sheep to the acre, while the poorer rough grazings can do no more than support, not fatten, one sheep per 5 or even 8 acres, a ratio of at least 50 : 1. But these are extremes. The average annual production in terms of meat has been placed at 90–100 lb. for permanent grass and at 5–15 lb. for rough grazings,[1] a ratio of approximately 10 : 1. These variations depend partly on the species of grass composing the sward and on the management of the sward,[2] and partly on the inherent qualities of the soil and of the climate. There is great variation, too, in objects of stock farming. Rearing and fattening require different types of land, and, as these are unevenly distributed, rearing and fattening have each a different geographical distribution.

It is necessary, first, to consider the main types of grassland and their several characteristics. (See Figs. 23 and 24.)

(1) The finest grassland is that consisting largely of perennial rye grass accompanied by wild white clover, which builds up the fertility of the soil by nitrogen fixation. Perennial rye grass is not the heaviest yielder, but it is leafy and does not grow coarse, as cocksfoot often does on good land. It is not easy to build up a rye grass sward, for not only must a suitable mixture be sown, but it must be managed correctly in order to encourage the rye grass and to discourage self-sown grasses and 'weeds' of less productivity.[3] The best rye grass pastures, such as those of the Leicestershire Lias with 84 per cent of

[1] R. G. Stapledon, *The Land: Now and To-morrow* (1935), pp. 79–80.

[2] Experiments at Rothamsted on the botanical composition of grassland prove the importance of management: 'a fairly uniform grass field has been changed into some 15 or 20 different floral types by varying the manurial treatment. The converse experiment was started in 1928. An arable field was divided into six parts, each of which was sown with a separate grass mixture, then the whole field was put under uniform management . . . the differences in flora rapidly diminished and by 1936 the plots were all very similar' (*Rothamsted Report for 1937*, p. 24). For similar experimental work under different climatic conditions, see the *Bulletins of the Welsh Plant-Breeding Station.*

[3] For an example in Devon, see E. W. Fenton, *Journal of Ecology*, vol. XIX (1931), pp. 75–97.

its acreage rye grass dominant,[1] will yield 180 to 200 lb. of meat annually, which is twice the productivity of average permanent grass. But such rye grass dominant pastures are restricted in extent. In the Vale of Aylesbury 49 per cent of the acreage sampled was in this class, and in South Cheshire approximately 40 per cent, but in Ayrshire only 3 per cent and in Carmarthenshire only 5 per cent was rye grass dominant. If cut late for hay, the clovers are smothered and fertility reduced: the type is best developed and maintained by skilful grazing, whereby the sward is kept short and leafy and the growth of grass is never allowed to outstrip the capacity of stock to graze it, nor is it allowed to be over-grazed.[2] It is also best maintained by grazing fattening bullocks or fattening tegs rather than young stock or dairy stock, for reasons which will be stated later. Rye grass pastures appear to be developed most readily on deep fertile soils retentive of moisture in a region of moderate rainfall. The Lias clays of Leicester and Northampton and river alluvium are examples of the most suitable soils. 'The grass thrives,' say Watson and More, 'on rich loams and clays and on such lands, in districts where the climate is good, it is truly perennial, but on poor, light land, and under northern conditions, it is liable to die out during its third year; moreover, on dry soils it is little resistant to drought.'[3] Prof. Hanley makes the same points, '. . . rye grass likes the same soils, but not the same climate, as wheat. Rye grass will not tolerate too high a degree of soil acidity and nothing harms rye grass so much as a succession of droughty springs or summers. . . . Sooner or later it deteriorates, and the drier the conditions the sooner this happens'.[4] It is not difficult to understand, therefore, why it is in the Midlands that the best rye grass pastures are to be found, for neither dry eastern nor wet western districts (with their tendency to soil acidity) favour it.

(2) The poorer permanent grass is characterized by *Agrostis*. *Agrostis* is among the poorer of the cultivated grasses, but is better than any of the grasses of the rough grazings: a sward with *Agrostis* is capable of improvement and colonization by better grasses, but, on the other hand, it is capable by neglect

[1] Rye grass dominant does not mean a sward of rye grass alone. A botanical analysis of five Welsh fields of this standard gave perennial rye grass as composing 30 per cent of the whole.

[2] For the effects of differing intensities of grazing and differing intensities of mowing, see R. G. Stapledon, 'Grassland', in *Agriculture in the Twentieth Century* (1939). Hard grazing (but not too hard) improves the fertility of the land more than lenient grazing; grazing more than mowing.

[3] J. A. S. Watson and J. A. More, *Agriculture. The Science and Practice of British Farming* (1933), p. 325.

[4] J. A. Hanley, 'Our Grassland', *Third Oxford Farming Conference* (1938), pp. 19–20.

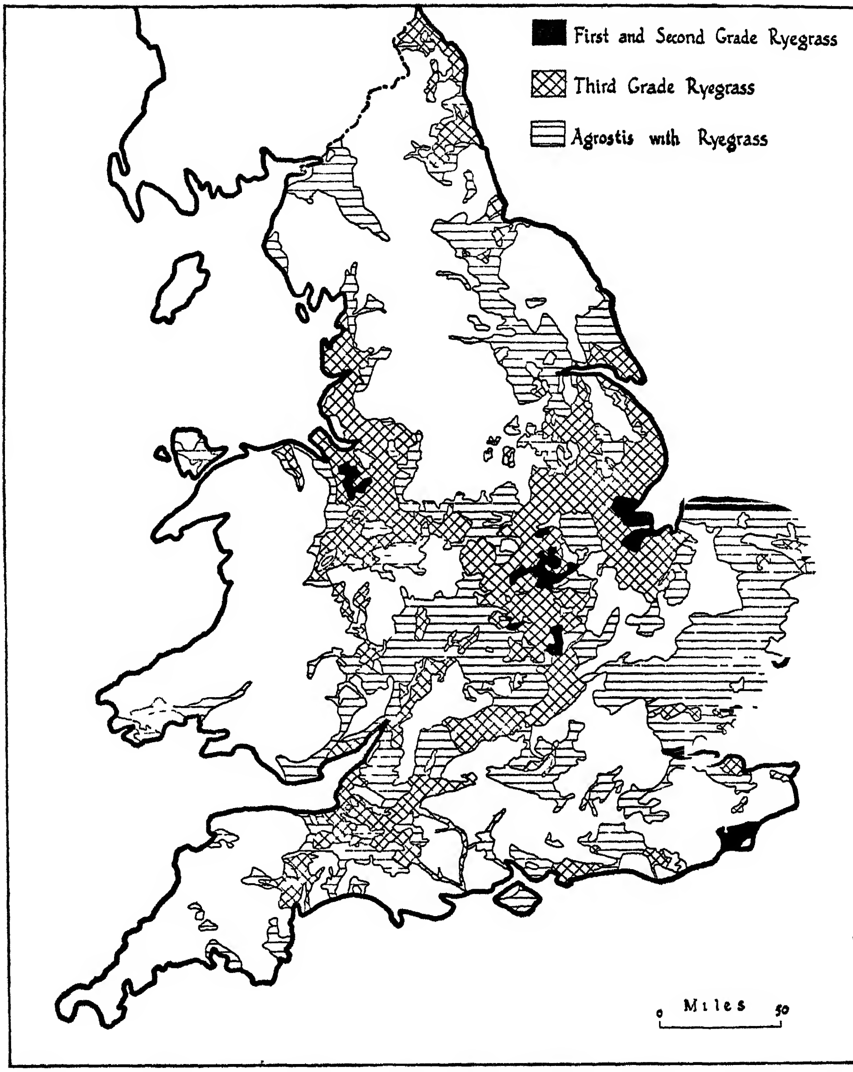


Fig. 23

GRASSLAND MAP OF ENGLAND AND WALES. I.

First and Second Grade Ryegrass, Third Grade Ryegrass, Agrostis with Ryegrass shown in order of decreasing density of shading. Redrawn by permission of Dr. William Davies from his Grassland Map of England and Wales. The map gives the quality of permanent grass in each district. It is not a map of the distribution of grassland in the land utilization sense, the Fenland, for example, having little grass

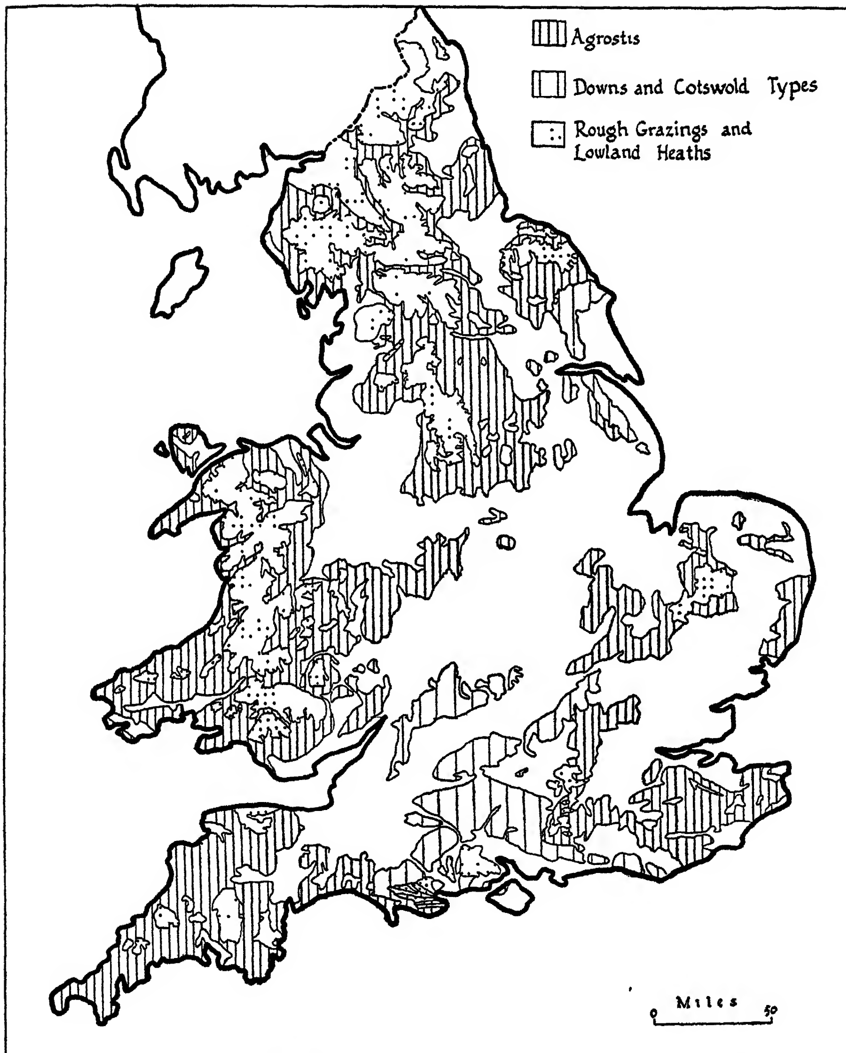


Fig. 24

GRASSLAND MAP OF ENGLAND AND WALES. II.

Agrostis, Downs and Cotswold Types, Rough Grazings and Lowland Heaths shown in order of decreasing density of shading. Redrawn by permission of Dr. William Davies from his Grassland Map of England and Wales. The map gives the quality of permanent grass and natural grass in each district. It is not a map of the distribution of grassland in the land utilization sense.

TABLE XXIII

Field-to-Field Samples of Grassland

	As percentages of total area sampled					
	Leics.	Bucks.	Ches.	Ayr	Glam.	Carm.
Rye Grass						
First grade . . .	41	8	—	—	—	—
Second Grade	43	41	37	3	—	5
Agrostis						
With some rye grass . . .	10	40	42	16	30	39
Without rye grass	3	3½	9	51	50	43
Rushes	—	—	—	6	5	10

From R. G. Stapledon, *The Land: Now and To-morrow* (1935).

and mismanagement of deterioration and colonization by the poorer grasses of the rough grazings. Even on the Leicester Lias in the sample quoted above 13 per cent of the acreage was *Agrostis* dominant. In the Vale of Aylesbury the percentage of the acreage with *Agrostis* dominant was 43 per cent, in South Cheshire 51 per cent, in Ayrshire 67 per cent, in the Vale of Glamorgan 80 per cent, and in Carmarthenshire 82 per cent. It would seem that *Agrostis* tends to multiply in western areas of heavy rainfall, productive of soil acidity. It thrives, says Armstrong, 'more especially where the rainfall is heavy or the soil is inclined to be wet. On dry soils its produce is very scanty.'[1] In each of the sampled areas where the percentage of pure *Agrostis* is high, rushes, indicative of the need of drainage, are also prominent. On very acid soils, on Millstone Grit and Coal Measures in industrial districts, whose smoke and fumes intensify soil acidity, there is a very restricted grass flora of a lower order than *Agrostis*.[2] The hayfields of West Norway, also in an area of heavy rainfall, are full of weeds, but constant cutting for hay with the resulting impoverishment of the soil may be partly responsible.[3]

(3) The best of the natural grazings are the sheep's fescue pastures. They are often associated with *Agrostis* to a minor extent and are often improvable up to that standard. They are native to the downs and wolds, to shallow mountain soils, to stabilized

[1] S. F. Armstrong, *British Grasses* (1917), p. 134.

[2] J. A. Hanley, 'The Need for Lime and Phosphate in Grassland Improvement', *Report of the Fourth International Grassland Congress* (1937), pp. 288–9.

[3] Unmanured grassland cut annually for hay unquestionably deteriorates. Two plots at Rothamsted yielded 22·6 and 25·1 cwt. of hay respectively in 1856–65, but only 10·9 and 14·0 cwt. respectively in 1906–15; there was also a marked deterioration in the botanical composition of the sward (*The Book of the Rothamsted Experiments*, pp. 153 and 173–83).

sand-dunes, and to some lowland heaths. It is shallow, relatively dry soils, both siliceous and calcareous, with limited reserves of plant food, that form their natural habitat: sheep's fescue is hardy, but has no great bulk of growth, and rarely grows more than a few inches high.[1]

(4) On wetter soils where drainage is impeded there are grasses with a greater bulk of growth than sheep's fescue, though having a shorter grazing season and a less palatable herbage. These are *Molinia*, or flying bent, in 'flushes' on shallow peat at moderate elevations, and *Nardus*, or mat grass, on acid peaty soils at moderate and high elevations. *Molinia* provides the greater bulk of growth. The spring growth of *Molinia* has a high feeding value, but it falls off rapidly after mid-August in nutritive quality.[2] 'Only cattle can keep pace with the rapidity of early summer growth—sheep soon neglect the maturing leafage—and the amount of valuable fodder that goes to waste every year . . . is prodigious.'[3] With the decline of the cattle population of the uplands the waste of herbage has been accentuated. *Nardus* provides a tough and unpalatable herbage, grazed by sheep only in its first growth in early summer, and it forms a surface mat smothering better grazing grasses.

TABLE XXIV

Nitrogen and Mineral Content of Produce of Several Classes of Grassland

	As percentages of dry matter		
	Nitrogen	Phosphoric acid	Lime
Rye grass group . . .	3·47	0·94	1·26
Agrostis-rye grass . . .	2·90	0·76	1·12
Agrostis group	2·42	0·59	0·81
Agrostis-fescue	1·98	0·44	0·39
Molinia-Nardus	1·57	0·26	0·32

From T. W. Fagan and R. O. Davies, 'The Nitrogen and Mineral Content of the Produce of Grassland', *Report of the Fourth International Grassland Congress*, (1937), pp. 372–3.

The relative value of these several classes of pasture is indicated by Table XXIV, giving the content in nitrogen, lime, and phosphoric acid, of each grade. The samples analysed have been collected in Wales. They are expressed as a percentage of the bulk of grass produced on each type and do not take into account the variation in bulk of yield between each type.

[1] Dr. William Davies places fescue pastures in Group B intermediate between Group A, cultivated grass, and Group C, rough grazing proper ('The Grassland Map of England and Wales', *Journal Ministry of Agriculture*, vol. XLVIII (1941).

[2] B. Thomas and H. W. Dougall, 'The Flying Bent', *Journal Ministry of Agriculture*, vol. XLVI (1939), p. 279.

[3] Stapledon, *The Land*, p. 37.

(5) There are, finally, cotton grass, heather, and bracken. Cotton grass grows on deep peat bog formed in areas of high rainfall with impeded drainage. It is of little use for grazing except in early spring, when the leaf-bases are eaten by sheep before young heather and grass have begun to appear.[1] Cotton grass is common on the flatter summits of the Pennines, particularly on the Millstone Grit, but it is found also on undrained lowland peat bogs, as in Galloway or Lewis. Heather is developed on thin peat in areas of heavy rainfall, but of only slightly impeded drainage, and it tends to replace cotton grass moor when the slope becomes steeper. Heather has a not inconsiderable grazing value and is eaten throughout the year by sheep and grouse. Its nutritive value is highest in early summer and is lowest in winter, but in severe winter weather it often provides the only grazing available.[2] Bracken is usually found on lower slopes than either cotton grass or heather and within the altitudinal tree limit. It is, in fact, the undergrowth of open oak woodland such as is native to many British hill districts, but it cannot grow in closely shaded woodland. Bracken is rarely grazed, and its chief economic use is as bedding. But its effect is chiefly deleterious, for, as its habitat is the lower altitudes, it competes for living space with pasture grasses. Its area is unquestionably increasing, particularly in Scotland and in western districts where it is colonizing land not only that adjacent to existing areas by means of the underground rhizome (its chief means of extension in drier eastern districts), but also land removed from existing areas by means of spores forming completely new colonies.[3] The extension of bracken has been due to the decline of ploughing in hill areas, to the decline in the attention given to upland grassland, to diminished cutting of bracken for bedding, and to the substitution of sheep for cattle which has been common in most hill regions, especially in the Highlands of Scotland. The heavy hooves of cattle bruise the young bracken fronds and so assist in keeping bracken in check.[4]

The cycle of grass growth through the year presents some important regional differences. In the North of England, on lowland grass,

[1] B. Thomas, 'The Composition of Draw-Moss', *Journal Ministry of Agriculture*, vol. XLII (1935).

[2] B. Thomas, 'Composition and Feeding Value of Heather', *Journal Ministry of Agriculture*, vol. XLIII (1937).

[3] H. C. Long and E. Wyllie Fenton, 'The Story of the Bracken Fern', *Journal Royal Agricultural Society* (1938).

[4] The acreages (in thousand acres) of each of these types of grass in England and Wales were calculated by the Grassland Improvement Station in 1941 as follows: rye grass, first grade, 251; second, 912; third, 4,317; *Agrostis*, 10,314; fescue, 1,499; *Molinia* and *Nardus*, 1,470. Fescue is frequently subordinate to *Agrostis* and to *Nardus*; this is additional to the 1,499,000 acres above.

the season of growth is little more than six months—April to September—though in an early year there is a substantial growth in March. The lying-out season for dairy cows is also a six-months' period—May to October—but these dates are dictated more by air temperature than grass growth, October being warmer than April. In the Pennine uplands of the North of England there is little more than a five-months' grazing season, for the lower spring temperatures delay grass growth, and little more than a five-months' lying-out season for the cool springs make it too cool to permit cattle to lie out-of-doors at night until the end of May. In eastern England the grass-growth and the lying-out periods are substantially similar to those of the lowlands of the North of England. But in the South-west Peninsula, with its warm winters, grass has a longer growing season and the grazing season is often extended until Christmas in the warm pockets along the south coast. Even in the less sheltered Vale of mid-Devon dairy cattle are left out by many farmers until the beginning of December.[1] Fig. 25 gives the monthly growth of grass for ten years expressed as a percentage of the total for those years on my lawn in Liverpool. Being the record of a lawn, it may not be altogether typical of grassland even in the same district, but it affords some indication of the sort of monthly variation that occurs and, as the lawn is cut frequently, its treatment simulates grazing conditions. Growth begins in March or April, according to the season (in a very early year it may begin even in late February), and increases to a maximum in May; it declines in June and July, but increases again to a second maximum in August; after September it declines rapidly, and there is hardly ever any growth after mid-October. The first maximum is that which is cut for hay and the second provides the aftermath. This growth-cycle has only a limited correlation with rainfall. The second maximum can be traced to the increased rainfall of August, but the months of the first maximum constitute a period of low rainfall, though much moisture is left over in the soil from winter when rainfall is high and evaporation low. The first maximum represents the culmination of the natural growth-cycle of the plant. It seems to be connected also with the availability of nitrogen in the soil after the decomposition of plant residues during the winter; nitrogen begins to become available with a soil temperature of 42° F.,[2] which is reached in West Lancashire in late March. Applications of nitrogen early in spring give an early 'bite' of grass. Fig. 25 gives the growth curve of grass at Cambridge in 1930. There was

[1] Of eleven farmers from whom returns have been obtained, four bring their dairy cows indoors at the end of October or beginning of November and seven in late November or beginning of December. I am indebted to A. Ferriday for these returns.

[2] G. E. Blackman, 'The Influence of Temperature and Available Nitrogen Supply on the Growth of Pasture in the Spring', *Journal Agricultural Science* (1936), pp. 642–7.

the same rapid growth in spring, but the secondary August growth was much smaller in quantity. In eastern England grass tends to burn up in late summer, while in western England, with less sunshine and more rainfall, growth is much better maintained. There is a seasonal variation in the nutritive quality of grass as well as in its bulk of growth. Late summer herbage, as compared with spring

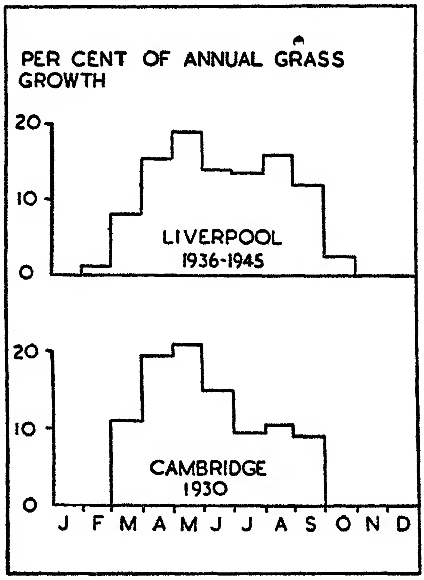


Fig. 25

MONTHLY GROWTH OF GRASS AT LIVERPOOL AND CAMBRIDGE

The Liverpool diagram has been constructed from the record of mowings of my lawn over a period of ten years: the Cambridge diagram from the record of mowings of a control plot on the University farm in 1930. The Liverpool lawn received annually a light dressing of a lawn fertilizer at the rate of 2½ cwt. per acre, the Cambridge plot a dressing of farmyard manure at the rate of 5 tons per acre, about what it would have received from droppings if grazed. It must be noted that the Cambridge data refer to a single year, the Liverpool data to the average for ten years. Cambridge data from H. E. Woodman and E. J. Underwood, *Journal Agricultural Science*, vol. XXII (1932).

herbage, is more fibrous and less nutritious, and stock have to eat more to obtain the same amounts of starch and protein. It is frequently necessary to feed cake supplements to dairy cattle and fattening beasts in late summer to make up the deficiency. Such cake is usually rich in protein to balance the protein deficiency of late summer grass, while if cake is fed in spring it is usually rich in starch to balance the high protein of spring grass.

The nutritional requirements of stock vary for different classes of animals, and they are able to utilize different kinds of grazing

TABLE XXV

Variation in Protein and Fibre of Grass during the Grazing Season

	23 Apr.	21 May	18 June	16 July	20 Aug.	24 Sept.
Crude protein .	26·1	25·1	20·3	22·5	22·4	21·1
Crude fibre . .	11·2	14·6	18·6	17·0	15·6	16·6

From H. E. Woodman and E. J. Underwood, 'Nutritive Value of Pasture, VIII', *Journal Agricultural Science*, vol. XXII (1932), pp. 60–70. The figures are percentages of dry matter and they refer to Plot A1 of the 1929 season.

with varying efficiency. These variations have an effect on the geographical distribution of stock. During the early stages of growth there is a demand for calcium and phosphorus for bone formation.[1] These are available in an assimilable form in almost all grasses, but in varying proportions, and they are likely to occur in greatest quantities on land treated with lime and basic slag or bone manure, or, in the case of calcium, on limestone and chalk soils, providing that the calcium has not been leached out. 'It has been found that the vegetative parts of plants growing naturally on calcareous soils contain greater amounts of lime than those growing on non-calcareous soils, although this is not always the case.'[2] The limestone uplands of the Pennines and the drift-free summit chalk of the downs are rearing districts which present these characteristics. Some other upland rearing districts have a shortage of limestone soils and, as generation after generation of growing (and milking) stock have eaten into the calcium and phosphate reserves, the carrying capacity of the land appears to be falling.[3] There is some evidence from the Alps to show that mountain grazing of young stock has beneficial effects on the organism, both in conformation, mountain-bred cattle being sturdier though smaller, and physiologically, mountain-bred cattle showing an improvement in blood composition and circulation.[4] As milk contains substantial amounts of calcium and phosphorus, milking stock also require these minerals in their food. 'Numerous workers have shown, in fact, that high-yielding cows at the peak of their lactations are invariably in negative calcium and phosphorus balance, i.e. they are losing more of these elements in their milk than they can assimilate from the food.'[5] Limestone and

[1] N. C. Wright, 'Feeding Standards for Farm Animals, V', *Journal Ministry of Agriculture*, vol. XLVI (1939). 'Bone develops early in life, then muscle, and lastly fat.' (J. Hammond, *Farm Animals* (1946), p. 81).

[2] R. P. Davies, 'Chemical Composition of Seed and Straw of Grasses', *Welsh Journal of Agriculture*, vol. XV (1939), p. 255.

[3] J. A. S. Watson, 'Some Impression of British Farming', V, *Journal Ministry of Agriculture*, vol. XLI (1934), pp. 252–4.

[4] J. Vezzani and E. Carboni, *Report of the Fourth International Grassland Congress* (1937), pp. 21–5. In this investigation the contrasting elevations were the Plain of Piedmont, at 790 feet, and Alpine pastures at 6,000–6,500 feet. These altitudinal contrasts are greater than anything in Britain.

[5] Wright, op. cit., p. 474.

chalk uplands serve as grazing for milking ewes as well as for young stock, but they serve as grazing for milking cows to only a limited extent. The reason seems to be that the fescue pastures native to these uplands provide grazing which is too scanty to provide the large intake of food which milking cows require, though upland temporary grass provides a greater bulk of food. Lowland grazings, particularly those of rye grass standard, are much more suitable for the dairy cow on account of their larger bulk of growth, but rye grass pastures tend to deteriorate under constant grazing of dairy stock unless lime and phosphates are added to the soil. Good lowland pastures are often too rich for young beasts, which do better by growing more slowly on poorer grazing, though they should not grow too slowly, especially when intended for meat production.[1] For fattening stock mineral requirements are very small and protein requirements are also relatively low. It is a ration rich in starch that fattening stock require, a ration such as is provided by good rye grass pastures with their great bulk of nutritious food. Any excess of protein can be voided in the dung and, in fact, dung from fattening cattle is richer in protein than dung from either dairy cows or young stock. Fattening stock take little in mineral reserves out of the soil, and the quality of the grazing is capable with care of being indefinitely maintained. On the best fatting pastures of the East Midland Lias neither milking ewes nor dairy cows are permitted and the quality of the grassland can thus be more easily maintained. Although the different grazing habits of cattle and sheep adapt them to different kinds of grazing, yet they are frequently grazed with advantage in the same field in lowland country either together or in succession, for they graze different levels of the herbage and they are immune from each others' diseases. Too heavy stocking with one class of stock alone is liable to cause parasitic infestation and it is often desirable to mix stock for this reason alone.[2]

For nutritional reasons, therefore, stock rearing is concentrated largely on upland areas, particularly where the soil contains available calcium; that is, on limestone and chalk uplands. Dairy stock and fattening stock tend to be kept rather on lowland grass, for such adult stock producing milk and meat require large quantities of food. Rye grass dominant pastures are the most suitable for the purpose, but *Agrostis* pastures are employed also for dairying, the deficiencies of the herbage being supplemented by cake. This distribution is confirmed by economic factors. The rearing of young stock is not as remunerative as the production of meat or milk, and rearing is possible as a regional activity only on relatively low-rented land and

[1] 'Breed improvement for beef consists in rearing animals on a high plane of nutrition and selecting for breeding purposes those which go through the age change in proportions quickest' (Hammond, op. cit., p. 54).

[2] E. T. Halnan and F. H. Gardner, *The Principles and Practice of Feeding Farm Animals* (1947), pp. 128–30.

on farms which are worked largely by family labour. Upland districts satisfy these conditions, for they are nearly always low in rent and are often, except on the chalk, worked by small family farmers.

II

REGIONAL VARIETIES OF GRASSLAND HUSBANDRY: ENGLAND

I will now turn to an analysis of regional types of grass farming, parallel to the analysis in the previous chapter of regional types of arable farming. I will begin with southern England.

The alluvial stretches of Romney Marsh and the Pevensey Levels present grazing of much superior quality to the average run of grass in Kent, Surrey, and Sussex. Soils vary a good deal from field to field in mechanical composition, but they are always more fertile than the parent material from which they have been derived. 'It is the depth to which the rich soil extends, the lack of any raw unweathered subsoil, and the presence of a permanent water-table close below the surface, which chiefly account for the fertility of the alluvial soils.'[1] They are usually high in humus and in nitrogen and are very productive, being classified as rye grass pastures, first and second grades, by the Grassland Improvement Station. On the best fields the rye grass strain is leafy and has a small percentage of fibre, while poorer fields, with a similar botanical analysis, have strains which tend to develop stem and seed early. Romney Marsh is grazed almost entirely by sheep and Pevensey Levels almost entirely by fattening cattle, it being held that Romney Marsh is too dry for cattle in the sense that it provides inadequate supplies of drinking water. The management of the grass is of a high order. It is always kept closely grazed and in a young leafy condition, the land being heavily stocked in summer. The best land on Romney Marsh carries six to eight ewes and their lambs to the acre. Being high in nitrogen, the soil would develop rank growth if it were not grazed heavily. Almost the only sheep breed kept is the Romney Marsh, for it is adapted to the harsh spring climate and the adult ewes are able to resist certain diseases to which sheep on the Marsh are liable.[2] The lambs, however, are wintered on poor grassland, mown for hay the previous summer, on 'upland' farms, whether on the Weald Clay or on the chalk. On a sample of parishes on Romney Marsh there were in 1936 only 7 head of cattle per 100 acres of grazing, but 425 head of sheep (120 ewes, 128 lambs, and 132 fattening tegs). Few other stock of any kind are kept. The cattle on the Pevensey Levels are adult bullocks; they are reared on 'upland' farms or are imported from the South-west Peninsula, Wales, or

[1] A. D. Hall and E. J. Russell, *Agriculture and Soils of Kent, Surrey and Sussex* (1911), p. 66.

[2] No other breed of sheep could be stocked so heavily (Halnan and Gardner, op. cit., p. 130).

Ireland. The summer grazing of the Norfolk Broadland exhibits an equally highly specialized economy. The land is too wet to be employed in winter and much of it is then under water, but in summer the alluvium provides good bullock grazing. The bullocks are now mainly under two years old, and the land is heavily stocked at the rate of almost a bullock per acre. This summer grazing can be worked in conveniently with the winter-yard fattening which, though now declining, has long been one of the staples of the husbandry of North-east Norfolk adjacent to the Broads.

The London Clay of South Essex is a stiff soil liable to develop soil acidity. Farther north, in North Essex, it is modified by drift. It is not a particularly fertile soil, and when neglected, as during the depression after the collapse of corn prices during the last quarter of the nineteenth century,[1] it yields very meagre crops and very poor grass, 'scarcely high enough to hide a lark', as Rider Haggard put it. But, when well farmed, crop yields and hay yields are on occasion, as in 1933, equal to those of any other region in the Eastern Counties, although in 1937 yields were relatively lower.[2] In the dry South Essex climate, with the least rainfall of all Britain, it is difficult to get a good 'take' of grass, and the South Essex Clays still have a relatively high percentage in arable. A sample of parishes in 1936 gave 32·3 per cent of the improved land as in arable.[3] The grass, however, tends to dry out late in the summer and the second flush and aftermath tend to be small: the aftermath is not registered by the hay yield, which is not a satisfactory index of full season grass growth. The density of stocking on this grassland is comparable to that of the country as a whole. The dairy cow is the chief animal kept, and the gross income from dairy produce is now well over double that from all other stock and stock products combined.[4] The average yield per cow in 1933 worked out at 609 gallons per annum, or 1·93 gallons a day for a lactation of 315 days.[5] These yields are equal to, if not higher than, yields in England and Wales as a whole.[6]

[1] As a result of this severe depression many farms became derelict and were only reoccupied after a lapse of years by farmers from other districts. An inquiry made in 1933 showed 36 per cent of co-operating farmers in South Essex to have been born outside the eastern counties and to have come in from Scotland, North-west England, the South-west Peninsula, and from other parts of the English Plain.

[2] *An Economic Survey of Agriculture in the Eastern Counties*, Reports nos. 22 (1934) and 26 (1938).

[3] The Cambridge Reports based on data collected from *sample farms* give a smaller percentage of the improved land in arable: 23·6 per cent in 1931, 28·0 per cent in 1933, and 24·7 per cent in 1937.

[4] In 1931 gross income per 100 acres of farmed land was £395 from dairy produce and £305 from other stock and stock products; in 1937, £729 and £301 respectively (*An Economic Survey of Agriculture in the Eastern Counties*, Reports nos. 19 (1932) and 26 (1938)).

[5] *An Economic Survey of Agriculture in the Eastern Counties*, Report no. 26 (1938).

[6] According to the 1930–1 Census of Agricultural Production the average lactation yield in England and Wales was 539 gallons, exclusive of milk fed to

The market supplied is that of London, and the bulk of the output is sold wholesale: 88 per cent in 1931 and 82 per cent in 1933. No milk is manufactured into butter or cheese on the farm. Production is maintained in winter as well as in summer, and fairly high-yielding cows are usually kept. Winter foods are available from the arable land on the farm, and it is less expensive to produce winter milk on the mixed farms of the eastern counties than on the grass farms of the west. The seasonal rhythm of milk production is dominated to a much smaller extent by the seasonal rhythm of grass. The South Essex London Clay is a grass-dairying district, but one very different in the detail of its management from the grass-dairying districts of North-west England or of the West Country. The London Clay extends into South Hertford and grass dairying extends with it, but the grass is poorer in quality and some is sour and acid.[1]

In the Market Harborough district in Leicester and Northampton is the finest permanent grass in the whole country.[2] According to the sample of Table XXIII, 84 per cent is rye grass dominant (41 per cent first grade, 43 per cent second grade); according to the particulars collected by J. Llefelys Davies, 41·5 per cent is first-class pasture and 32·1 per cent second-class.[3] This high quality is a product partly of the physical terrain, a deep strong soil and a medium rainfall. The poorer grazing often occupies drier fields on the slopes, but in some cases it belongs potentially to the first-class grade, having deteriorated 'either through bad management or by the introduction of dairy farming'.[4] The high quality of the grazing is thus a product not only of the land, but partly also of management. Young stock and milking stock remove nutrients from the soil and, unless the land is suitably fertilized, the quality of the grazing deteriorates. Hence graziers allow only fattening bullocks and tegs to graze the best pastures: the tegs are kept only during the winter, when bullocks would poach the strong land, and during the first flush of grass in spring and early summer, when the land has to be stocked heavily in order to keep the sward short and leafy. The fifty-two grazing farms from which J. Llefelys Davies collected particulars in the 'twenties had 8,808 feeding cattle, 665 young

stock. If 10 per cent be allowed for milk fed to stock, the average lactation yield for the country as a whole would be 599 gallons. For the milk-recording year 1933–4 the average yield for those herds in Essex recorded under the scheme was 817 gallons and for the recorded herds of England and Wales as a whole 731 gallons.

[1] R. G. Ferguson, 'A Survey of the Grassland of Hertfordshire', *Journal Ministry of Agriculture*, vol. XLIV (1937), pp. 335–43.

[2] There has, of course, been a good deal of ploughing-up during the war, but, at the latest by 1943, it was clear that much would have to be resown to temporary grass if the land was to be kept in good heart. The same need for reseeding was recognized in Lancashire about the same time.

[3] J. Llefelys Davies, *Grass Farming in the Welland Valley* (1928), p. 15. His classification was that of an agricultural economist and not that of an agricultural botanist.

[4] Stapledon, *The Land*, p. 14.

and dairy cattle, 8,815 fattening tegs, and 6,178 ewes and lambs. Even these farms had some fields of inferior grass, and on these the non-feeding stock were placed, the deficiencies of the grazing being supplemented by cake. On the strong land the graziers reckon to fatten one adult bullock and one adult sheep per acre during the grazing season. These same farms had 6,938 acres of first-class pasture, 4,038 of second-class pasture, and 2,043 of third-class. The stocking of the pasture works out, therefore, at approximately one and one-fifth stock units per acre on the first-class grass, three-quarters of a stock unit per acre on the second class, and half of a stock unit per acre on the third class, the stock unit being an adult bullock or dairy cow.[1]

Bullocks are put into the first-class pastures at the beginning of May. They are usually bought in from rearing districts, and, if they have been wintered in the district itself, they have been grazed on the drier, poorer land. The grazing is stocked heavily during the first flush of grass and new beasts are bought and placed in the fields to keep pace with grass growth. In this way grass is prevented from becoming fibrous and is preserved at a high level of nutrition. By the time the quantity and quality of grass is falling away in July some of the three-year-old cattle are ready for slaughter and the number of stock is adjusted to the feed available.[2] They continue to be sold during the summer, and fresh stock are bought in for the second flush of grass in late summer, but these are rarely fattened except with the aid of cake, and are sometimes carried through the winter in store condition to be fattened early the following summer. The best fields receive little fertilizer, but stock droppings are carefully collected and spread. Droppings of bullocks are richer in soil nutrients than droppings of young and milking stock.

Three-year-old bullocks have been, in the past, the staple of the district, and they still remain so in the heart of the area, although younger stock are now being kept more extensively than formerly. Out of a sample of 1,014 beasts, Bridges and Jones found that 571 were bullocks of three years old or over. These cater for the hotel and restaurant trade, for which large joints are still in demand. For the general household market, smaller joints are now required on account of the decreased size of the average family and younger, less mature, cattle are in favour for this market. These were the

[1] This calculation of stock units is only approximate, for not all the necessary data are available. I have taken five ewes, or tegs, as equal to a bullock in the above calculation. Llefelys Davies himself makes a calculation in the form of sheep units per acre, making allowance for the length of time on the farm and calculating to a twelve-months' year and the whole acreage of the farm. Taking seven sheep as equivalent to a bullock, he arrives at 4·47 sheep units per acre, but the basis of the calculation is statistically different.

[2] For an account of standard practice in the district by a local grazier, see H. H. Pickering, 'Stocking Pastures', *Journal Ministry of Agriculture*, vol. L (1944), pp. 537–40.

conditions prior to the institution of meat rationing during the late war. Few grazing districts now keep three-year-old bullocks, and they remain in considerable numbers only in special areas of which the Market Harborough district is the chief. Many graziers here hold that the adult three-year-old bullock fattens more successfully on the strong land than younger cattle, which are liable to scour and exhibit in consequence retarded growth. When in a half-fat condition, three-year-old bullocks fatten more quickly and have a greater live weight increase per day than younger beasts.[1] Fattening earlier, these three-year-old beasts are marketed early while prices are still moderately high and before they fall to the autumn minimum, when great numbers of grass-fed stock are unloaded on to the market.

The southern end of the Oxford and Kimmeridge Clay Vale, that is, the Vale of North Wiltshire and the Vale of West Dorset, constitutes, together with the Somerset alluvium, one of the two largest and most densely stocked grass-dairying districts of the country. The area is almost wholly in permanent grass, which accounted before the late war for approximately 90 per cent of the improved land. The soil is deep, the climate warm, the rainfall moderate in amount and well distributed throughout the year, all conditions suitable for grass growth and for a long growing season.

The Somerset alluvium, except the teart land where the alluvium is derived from the Lower Lias,[2] is rich, heavily stocked land. 'The best soils in this district will fatten a bullock an acre, and keep two sheep in the winter',[3] but, as dairying is now more profitable than fattening, milk rather than meat has become the chief objective. There was in 1936 a density of 26·9 cows and heifers in calf or in milk per 100 acres of the agricultural area, but only 4·9 feeding cattle. This is a traditional cheese-making district, and in June 1927, in Somerset as a whole, two-thirds of the total output was manufactured and of this one-third was made into cheese.[4] In a district in Central Somerset, lying between the Mendips and the Poulden Hills, the proportion manufactured was 73·4 per cent in 1931–2 and 88·4 per cent in 1934–5. The district is thus primarily a manufacturing one, and under the Milk Marketing Board the manufacturing function of Central Somerset has tended to become more pronounced. The amount sent to London for liquid consumption is greatest in winter, both in actual quantities and as a percentage of the total production, for in this season dairying regions nearer London are unable to supply the whole of its demand; and it is least in summer when the

[1] A. Bridges and A. Jones, *The Midlands Grazing Industry* (1931), pp. 22–3 and 26–7. The older beasts were prominent enough in 1948, still.

[2] W. R. Muir, 'The Teart Pastures of Somerset', *Agricultural Progress*, vol. XIII (1936), pp. 57–9.

[3] W. D. Hay, 'The Agriculture of Somerset', *Agricultural Progress*, vol. XIII (1936), p. 37.

[4] F. J. Prewett, *A Survey of Milk Marketing in Wiltshire and Somerset* (1928), pp. 53–4.

cheese, butter, condensed milk, and milk powder are mainly manufactured.[1] It is in this part of Somerset that the cheese-making farms are concentrated. Cheddar, the local cheese, is the chief variety made, but Caerphilly is also manufactured for the South Wales market. The former is made in the rolling land of the eastern districts, the latter in the flatter land of the western. Production is highly seasonal, the excess of summer production over winter being in the 'thirties 48 per cent.[2] Cheddar is almost wholly made in summer, but Caerphilly must be eaten soon after manufacture, and is made in winter as well. Summer cheese production is a general rule, for it is an arrangement designed to concentrate production into the grazing season when feeding costs are lowest. Being thus a milk manufacturing district, Somerset is external to the English Plain, not only physically, but also in the nature of the use to which its milk production is put, for there is little manufacture in the dairying districts of the English Plain proper.

In the Vale of North Wiltshire the percentage of arable is slightly higher than on the Somerset alluvium. The arable is, however, strictly subordinate to grass. There are very few sheep and very few fattening cattle: the dairy cow is again the chief objective of farming. Milk production is mainly sold liquid, the proportion in Wiltshire as a whole in 1927 being 62·5 per cent,[3] for the Vale of North Wiltshire is within the range of collection for the London market. The main line of the former G.W.R. passes through it. The greater part of Somerset in 1927 lay beyond the limit of collection for the London retail market, except in winter, when Wiltshire supplies occasionally ran short. This was still true ten years later.[4]

The Vale of West Dorset or Blackmore Vale, carved mainly out of the Oxford and Kimmeridge Clays, is a district of small grass farms worked by family labour and having milk as its primary objective. It is Hardy's 'Vale of Little Dairies.' Only 6·4 per cent of the total cultivated area was in 1936 in arable, and there is only a small acreage in rough grazings. The dairy herd then constituted about two-thirds of the grazing stock, equated according to grass consumption, the rest being a few young and fattening cattle, a few sheep, horses, and poultry. The number of dairy stock per 100 acres of the agricultural area was 24·1, of other cattle over two years old, only 4·5; but the region was once a summer bullock-fattening district.

[1] B. L. Smith and H. Whitby, *Milk Marketing Before and After Organization* (1937).

[2] In 1948–9 the corresponding figure for Somerset was 22 per cent.

[3] Prewett, op. cit., p. 53.

[4] For the 1945 crop year a sample of twenty-seven farms obtained an average of 76 per cent of their 'production' from milk and had an average of 30 per cent of their acreage in arable. The average number of gallons per cow was 603 and of cows per farm 43. I am indebted to Dr. C. V. Dawe for these returns.

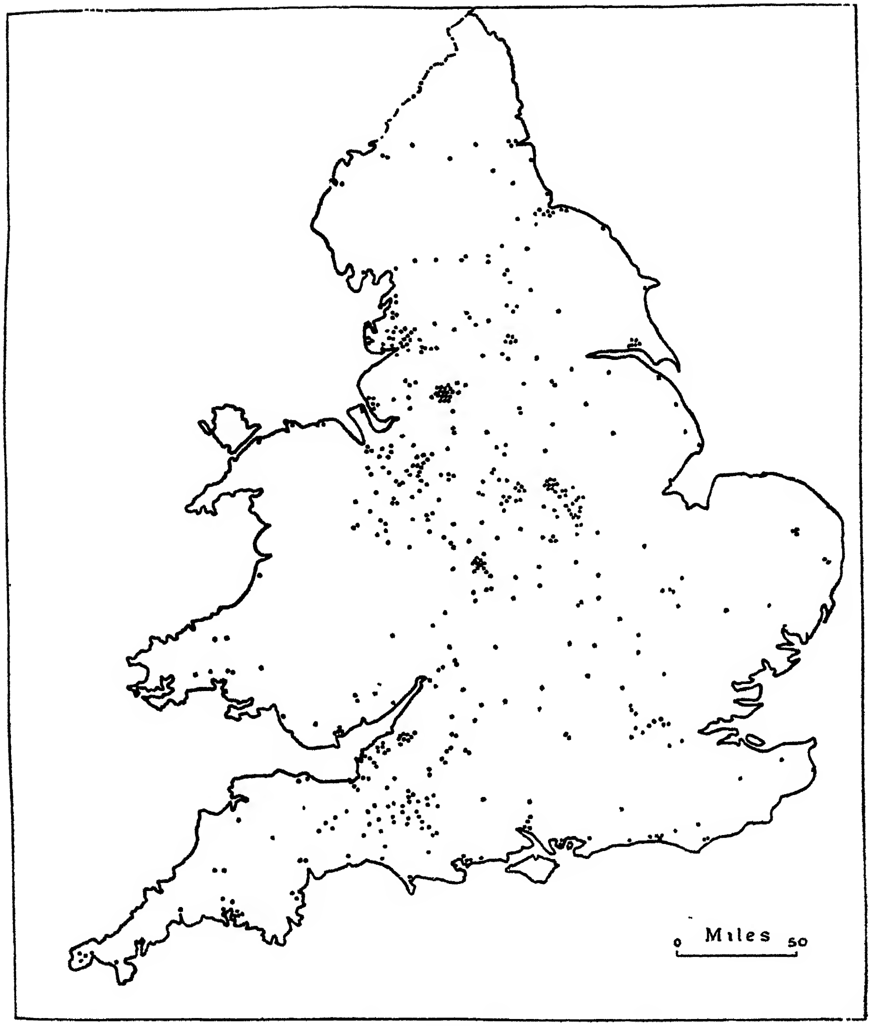


Fig. 26

MILK MANUFACTURERS IN ENGLAND AND WALES, 1934–35

Each dot represents the site of one milk manufacturer. The map includes farm-house cheese-makers, factory cheese-makers, waste milk cheese-makers, milk powder factories, baby food factories, condensed milk factories, chocolate factories, butter factories. It may not register all manufacturers within each category.

Except near Sturminster Newton the dairy cow has replaced the fattening bullock.[1] On a sample of ten farms,[2] the average number of cows per farm (1931–2 to 1934–5) was 27·2, and the average yield daily per cow 1·6 gallons over the year, being 1·9 gallons during the summer half-year (April to September) and 1·3 gallons during the winter half-year. This range between winter and summer production was higher than the average at that date, but the winter percentage has since increased, being 48 in 1948–9. This change is correlated with a greatly diminished farmhouse butter and cheese manufacture and with an increased reliance on the sale of whole milk, even before the war.

Herefordshire, along the Welsh Border, has a relatively dry climate like much of the English Plain. Its heavier soils are in grass of good quality, and, although largely in arable, the lighter soils also have some grass, though it is of poor quality and often very weedy. Occasionally good grass is encountered on these light soils, but good management is obviously responsible. The grass on the strong soils is mainly devoted to cattle fattening, for which the local breed is best adapted. There is only a limited local demand for milk, and the region is off the main railway routes to London and the Midland towns, the South Wales coalfield being supplied by dairying districts in South Wales itself. Dairying has, however, increased since the motor-lorry facilitated local milk collection: there are scattered individual dairy farms, in addition to those suburban to Hereford and Malvern, and there is a creamery in the Lugg Valley. I have inventories of stock in April on a random sample of half a dozen farms, of which one was primarily a dairy farm and one primarily a feeding farm, the rest practising an all-round stock economy. The cattle are Shorthorn and Hereford, except on the dairy farm, and in April most of the cows were still in calf. Except on the dairy farm, cows suckled their own calves. These are all attributes of a breeding as distinct from a dairying district, for in a non-rearing dairying district calves are mostly sold off the farm shortly after birth and, when reared, calves are pail-fed. Rather more feeding cattle than breeding cows and heifers are kept on these farms. The sheep are varied in breed, the ewes including Suffolk, Ryeland, and Blackface, all grass sheep, and the rams are of Down breeds. In April lambing was still in progress. The feeding farm kept only fattening bullocks and fattening tegs.

Marginal to the English Plain and similar in this respect to Somerset are the rich lowland grass districts of South Cheshire (with the adjacent fringes of Salop, Denbigh, and Flint) and of South Derbyshire[3] (with adjacent parts of Staffordshire). Separated from

[1] Tavener, op. cit., pp. 60–1.

[2] F. H. Villiers, *Farm Economist*, vol. II (1936), pp. 9–10.

[3] For the very interesting regional variations within Derbyshire, see F. J. Prewett, *A Survey of Milk Marketing in Derbyshire* (1930).

the Cheshire grass district by the arable district of North Cheshire and South-west Lancashire is the Fylde, in North Lancashire, which is essentially similar in the quality of its grass and in the character of its stock economy. These districts, like those of the West Country, are all primarily dairying regions. Their climate is intermediate between the wet districts of the western seaboard and the dry districts of eastern England; their soils are deep medium-strong loams, except on the Carboniferous Limestone of Derbyshire, but this has the compensatory advantage of calcium which milk secretion requires. All these districts, moreover, are alike in their comparative proximity to industrial centres and, though most of them were once important cheese-making districts and though some remained so until the war, their milk production now mainly enters the liquid milk market.

South Cheshire is a district of grass farms, having only a few fields in arable. Farther south in North-east Salop, the morainic mounds and the outwash gravels and sands give a soil too light for first-class grass. The heavier loams, derived from the boulder clay, are in grass and only the lighter land is under the plough for a cash crop of potatoes and for roots, straw and hay for winter feeding. The grass, though below the Market Harborough standard, is classified by the Grassland Improvement Station as second-grade rye grass. For a west coast situation the rainfall is relatively low, for the Cheshire Plain is in the rain shadow behind Snowdonia; under conditions of good management, this permits the development of good rye grass pastures. South Cheshire grassland for a century has been fed with bone meal and to-day with manurial residues from cake fed to the dairy herd. It is good land, it is heavily stocked, and it is well managed. Though once having much more arable than at present, South Cheshire has long been a dairying and a cheese-making district with a local variety of cheese of high repute. Its grass, for reasons yet to be discovered, favours milk secretion rather than live weight increase. The late-ripening varieties of Cheshire cheese made at the height of the grazing season will keep for twelve months, and Cheshire cheese is therefore made during the grazing season, in spring, summer, and early autumn, when milk is produced most cheaply. The classical system was that cows were arranged to calve in the spring at the time of the spring flush of grass, and to go dry by Christmas, thus yielding little milk during the winter when artificial feeding is necessary. Such stock could be wintered on hay without cake. As late as 1911 it was reckoned that in East Denbigh the return from cheese-making and from feeding the whey to pigs was about equal to the return from the sale of whole milk for liquid consumption.[1] But for North and East Cheshire, nearer to large centres of liquid milk consumption, milk-selling was more profitable by 1911 and cheese-making had come to be limited to South Cheshire,

[1] Hall, *Pilgrimage*, p. 212.

with an outlier round Oswestry and in North-west Salop. Many of the Welsh Border farms made butter rather than cheese. Since that date farmhouse cheese-making, though producing a high-grade product, has been on the decline even in South Cheshire.[1] An integral part of the system has been the feeding of the whey to pigs, usually fattening baconers bought in spring as stores and sold in autumn at 200 lb. live weight or thereabouts.[2] The amount of whey available for pig feeding worked out in South Cheshire at about 0·6 gallon per gallon of whole milk. It is possible to keep a pig to a cow, but pigs were not often in Cheshire fed as much whey as that ratio implies. The South Cheshire farm, with its large herd of milking cows and its large number of pigs, usually presents a steading of some size, with shippons and piggeries arranged around a courtyard and with a substantial half-timbered or brick farmhouse detached from it. This system has changed substantially since 1939.[3] The market served is Cheshire and Lancashire, little now going outside these counties.

The Fylde, in West Lancashire, has an environment very similar to that of South Cheshire. The Keuper Marls, which, as in South Cheshire, form the underlying platform, are everywhere overlain by a hummocky sheet of boulder clay. In the hollows and on the flats of the boulder clay surface peat has accumulated, and there is a fringe of blown sand along the coast. The stiff loams of the boulder clay were formerly in arable and at the end of the eighteenth century the Fylde was known as the granary of Lancashire, but, with the changes in the economic environment during the course of the nineteenth century, changes which encouraged dairying and discouraged corn, the stiff loams were laid down to grass[4] and the farm steadings were remodelled to provide shippons arranged around a courtyard, as in South Cheshire. The farms, however, are smaller in size and the farm buildings less elaborately planned. The arable is now mainly on the drained peat or moss and on the sandy loams near the coast. The black lands, that is, the drained peat soils, are naturally high in humus and yield heavy crops of oats, potatoes, and hay. The arable helps to provide winter food for the dairy herd, and it provides a profitable outlet for the dung accumulated during indoor winter feeding, and of which the Fylde farmer has an excess. The grassland is heavily stocked, stocking working out in early June at 0·92 of a grazing unit per acre of grazing available at that time of the year.[5]

[1] W. B. Mercer, 'Two Centuries of Cheshire Cheese Farming', *Journal Royal Agricultural Society* (1937), p. 89. It almost disappeared during the war.

[2] Average live weights of summer-fed pigs at Reaseheath, near Nantwich, is 189 lb. (S. Barrett, *Journal Ministry of Agriculture*, vol. XL (1933), p. 432).

[3] Milk selling is now the rule, production has been evened out as between winter and summer and the flying flock replaced by home-reared heifers.

[4] W. Smith, 'Agrarian Evolution since the Eighteenth Century', *A Scientific Study of Blackpool and District, British Association Reports* (1936).

[5] The grazing unit is a cow in milk of 10½ cwt. live weight, yielding 2 gallons of milk daily and getting the whole of her food from grazing. Other stock are equated

Dairying in the Fylde was formerly devoted very largely to farmhouse cheese-making and the product was the soft, crumbly Lancashire cheese. But farmhouse cheese-making has retreated from the Fylde proper to more remote areas on the slopes of Bowland. The milk production now passes almost wholly into liquid consumption and is sent partly to the seaside towns, which present a seasonal demand, and partly to the industrial towns of South Lancashire, which present a level demand except during the annual Wakes weeks.

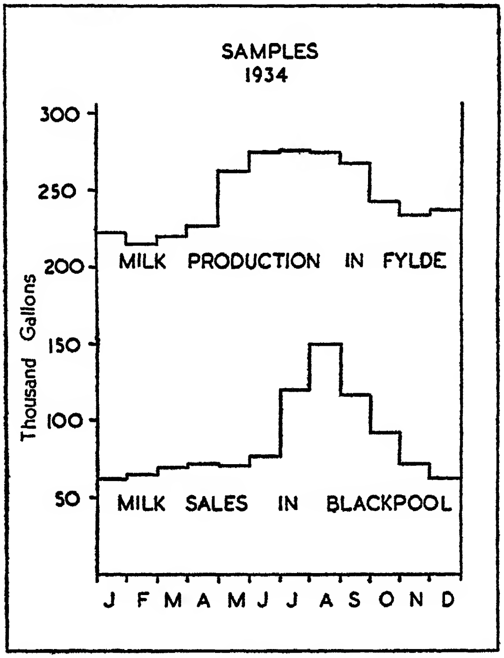


Fig. 27

MILK PRODUCTION IN THE FYLDE AND MILK SALES IN BLACKPOOL, 1934

Samples of production and of sales in each case. The diagram is designed to show the seasonal rhythm rather than the absolute level of production and sales.

The Fylde turned over to milk-selling more readily than did South Cheshire, and the reason probably lies in the more restricted demand for the less well-known Lancashire cheese, the two districts being more or less equidistant from industrial Lancashire. The seasonal rhythm of milk production is closely adapted to (*a*) the seasonal

to this standard according to their grass consumption at this time of the year. The grazing excludes the land put up for hay (W. Smith, 'A Live-Stock Index for the Fylde District of Lancashire', *Empire Journal of Experimental Agriculture*, vol. VII (1939)).

variation in the growth of grass and (*b*) the seasonal variation in the demand for milk. Milk production increases rapidly in spring to a maximum in May as a response to the spring flush of grass, but, unlike cheese-making districts, it does not decline as the growth of grass slackens, but is maintained until the end of August in order to meet the increased seaside demand during the holiday period. Production is maintained only by bringing in newly calved cows and by increased feeding of cake to counteract the fall in the net nutritive value of the grazing. Thus is the milk production curve modelled by the combined effects of the physical environment, acting through

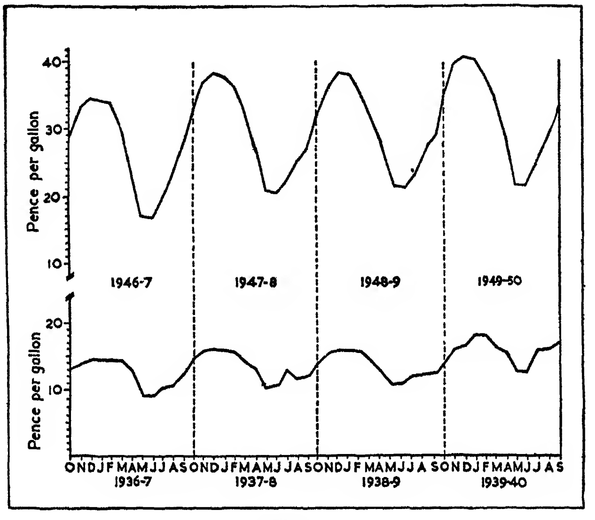


Fig. 28

WHOLESALE PRODUCERS' PRICES OF MILK

The seasonal rhythm is displayed in both periods, but it will be noticed that the magnitude of the winter increase in price has increased both absolutely and relatively in the post-war as compared with the pre-war period. This change in the magnitude of the winter price has had effects on the seasonal rhythm of production as Fig 29 shows. The seasonal pattern of prices is however fixed by the relative costs of grazing and of winter feeding, being lowest in May–June when grass is most plentiful and most nutritious and being highest in mid-winter when most stock are indoors. Drawn by permission from the returns of the Milk Marketing Board.

the vehicle of grass, and of the economic environment, in the form of the demand for milk.[1]

The dairy cow is the chief animal kept. As grazing units, the dairy herd accounted in 1934 for 12,084·8 units out of a total, exclusive of poultry, for the twenty-four parishes of the Fylde of 18,456·2 units. Apart from the farm horses, sheep and poultry are the most important after cattle. Pigs are kept to only a limited

[1] W. Smith, 'The Agricultural Geography of the Fylde', *Geography*, vol. XXII (1937).

extent and, as pigs are fed on meal, the Fylde offers them no particular attractions, except in the case of a few herds near the seaside towns fed on food refuse from hotels and boarding-houses. The sheep are Half-bred ewes bought in from farther north and mated with Suffolk rams for early fat lamb ready before the late war at 60 lb. live weight by Easter, if it is late, or between Easter and Whitsuntide, if Easter is early. The ewes and lambs are thus in part removed

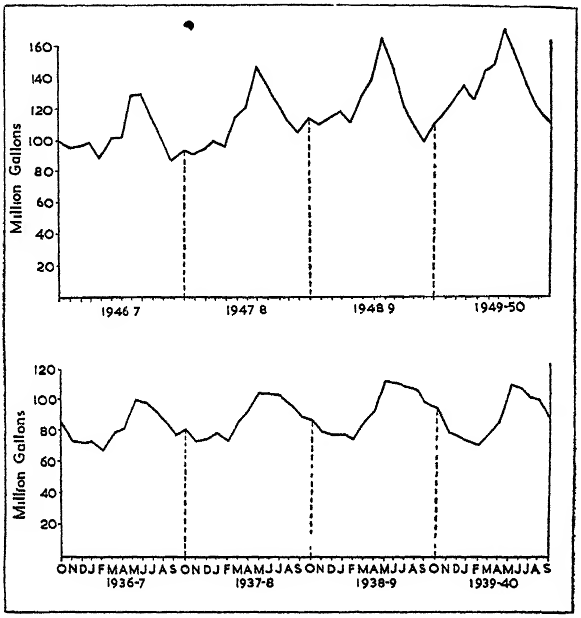


Fig. 29

MONTHLY SALES OFF FARMS

Both periods display the early summer peak, but the peak was more prolonged throughout the summer in the pre-war years than to-day There are now fewer feeding stuffs available for late summer feeding. Moreover, the month of minimum sales has recently shifted from February to September. This is a result of the increase in winter production and the autumn calving designed to take advantage of the winter bonus. Drawn by per mission from the returns of the Milk Marketing Board.

from the pastures before the dairy herd is put out to grass at the beginning of May. Poultry are present in immense numbers, the Fylde being the most densely populated poultry district in the whole country. They are kept partly in wired runs by specialist poultry farmers near the main roads and partly by general farmers on open range in fields grazed by sheep or the dairy herd and housed in large flock cabins, the 'Lancashire cabin'. The eggs find the same markets as the milk—the seaside towns and industrial Lancashire.

16

The Central Pennines in the environs of the industrial towns of Lancashire and of the West Riding constitute a grassland region entirely devoid of arable, except under the exigencies of war, unless it be of an occasional field about to be resown to grass. It is more

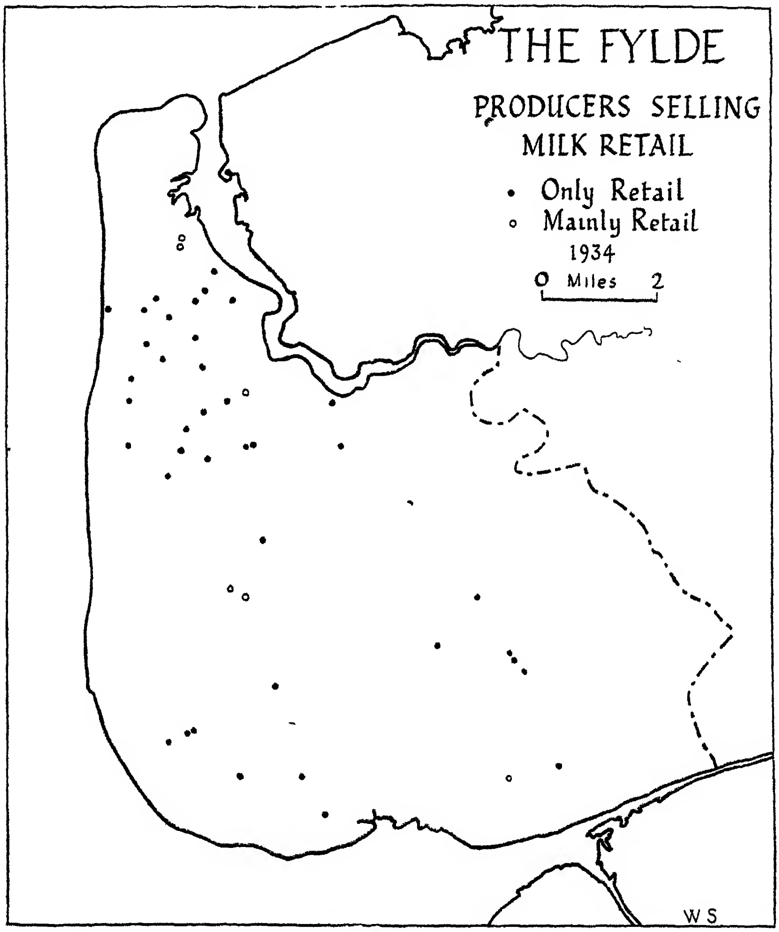


Fig. 30

MILK PRODUCERS IN THE FYLDE ACCORDING TO METHOD OF DISPOSAL, 1934. I.

Producers selling milk retail.
Each dot represents the site of one farm.

exclusively in grass than any other region of similar dimensions in the whole country. The soils have been formed from the Millstone Grit and the Coal Measures, or, on the western flanks, from boulder clay derived from these; they are poor soils with few plant nutrients and, occurring in a region of heavy rainfall and of industrial and

domestic smoke, they tend to be sour and to exhibit a high degree of acidity. Unless well cared for, grassland on these sterile hillsides degenerates to a very low level of productivity. It is a month or so later than the Fylde or South Cheshire in starting grass growth in

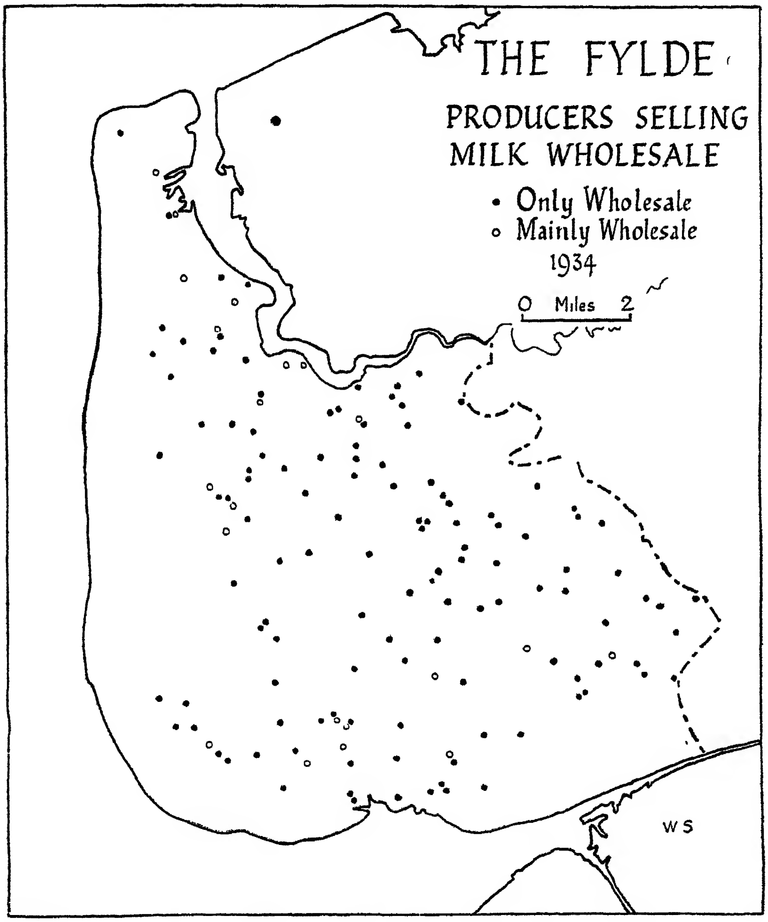


Fig. 31

MILK PRODUCERS IN THE FYLDE ACCORDING TO METHOD OF DISPOSAL, 1934.
II.
Producers selling milk wholesale.
Each dot represents the site of one farm.

spring, and a month later in the grass being ready for mowing in summer, hay not being made frequently until August. There are, however, striking contrasts in the quality of the grass in adjacent fields, having the same soil and the same climate, but differing only in management. Some land was being ploughed and resown even

before 1939, and much more has been involved during the war. The new sward stands out a bright green in contrast to neighbouring fields. The stock kept on the improved land are practically limited to dairy cows, to sheep, and to poultry. Milk and eggs are the chief

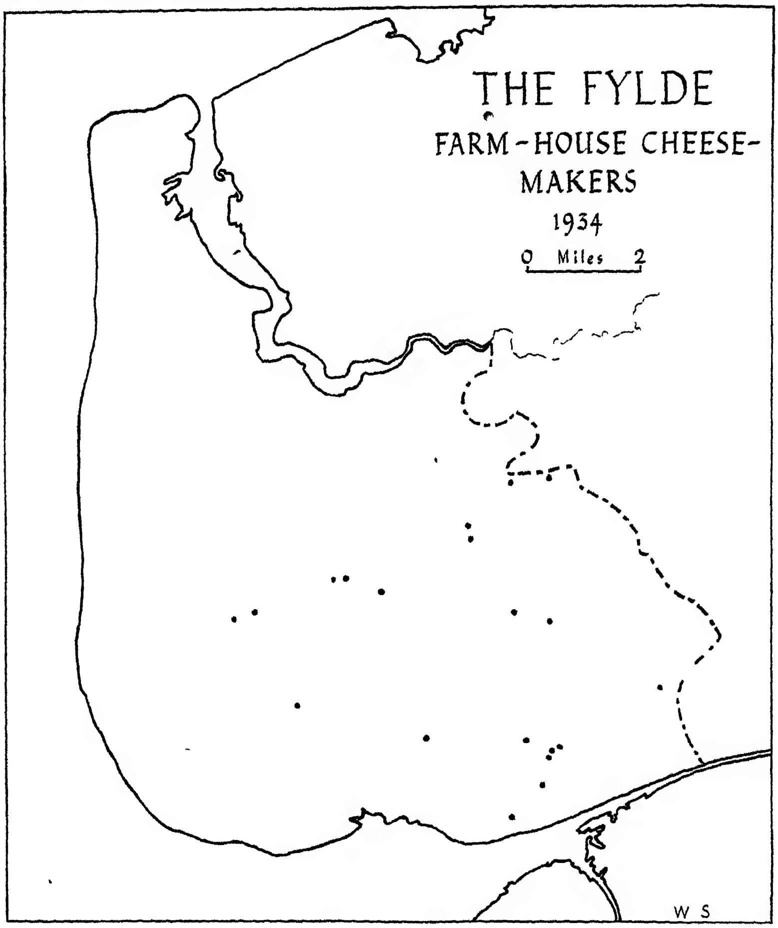


Fig. 32

MILK PRODUCERS IN THE FYLDE ACCORDING TO METHOD OF DISPOSAL, 1934. III.

Farm-house cheese-makers.
Each dot represents the site of one farm.

products of the farm and the producer-retailer is the common form of economic organization.[1] The sheep are kept for wool and for store lambs. The manure from this stock has improved many

[1] In Bolton nine-tenths of the licences issued for retailing milk were to producer-retailers and in Halifax three-quarters (*Report of the Reorganization Commission for Milk* (1933), p. 28).

Pennine fields even at high elevations. They carry a surprisingly high density of stock on the *improved* land, the usual density in actual numbers being about half that of lowland dairying districts,[1] but in some cases the improved land carries almost as many head of stock as lowland farms.[2] It must not be forgotten, however, that on these upland Pennine farms practically all the production requirement (summer as well as winter) for the dairy herd is bought in, grazing being sufficient only for maintenance. The rough grazings, which are *Nardus* and *Molinia* rather than fescues, carry very few stock. The plateau summits have vast stretches of cotton grass moor and are largely waste, a condition accentuated by the policy of the water authorities of Lancashire and the West Riding industrial towns in depopulating their catchment areas of man and beast in order to prevent water pollution. In the Central Pennines, almost every moorland valley carries a reservoir. Costs of production are high, for dairy stock have often to be bought in from other districts, and the greater part of the production ration has to be purchased. An interesting speciality of the district is the industrial form which poultry-keeping has developed, particularly in the narrow valleys about Todmorden, Hebden Bridge, and Mytholmroyd. Disused mills have been used for the intensive feeding of laying hens, and these valleys have developed the day-old chick business, the chicks being hatched in heated incubators and dispatched by passenger train a few hours after birth. Many of the workers in the specialist poultry businesses of the Pennine valleys had formerly been textile workers, but become unemployed in the post-1920 depression.

In the limestone dales of Craven and the Northern Pennines generally, a different type of grass farming is practised. The residual soils of the Carboniferous Limestone carry good fescue pasture up to altitudes of 1,700 feet, but on the Millstone Grit there is little land over 1,000 feet that is not in *Nardus*, *Molinia*, heather, or cotton grass. On the floors of the dales there are rich alluvial soils, some of which are of fatting standard. The physical environment of the limestone dales thus presents land initially of better quality than that of the Central Pennines. The economic environment is also different. The dales are removed from centres of population and their grass farming has been coloured by this condition. Traditionally, they have been stock-rearing and cheese-making districts, but, with the increase in the urban milk demand and in the facilities for rapid milk transport, milk is now largely sold wholesale. Stock rearing and dairying, whether for cheese or for liquid milk-selling, do not, however, exhaust the stock economy of the limestone dales.

[1] A common measure of stocking is 1 cow and 1 sheep per 2 acres.

[2] A farm near Bradford (Yorkshire), in 1939, carried 112 cows on 100 acres, but concentrates were brought in to the extent of £1,600 per annum, approximately 3½*d.* per gallon of milk produced ('This is my Farm' 2, *Journal Ministry of Agriculture*, vol. LII (1945), pp. 405–6).

The holmes, the alluvium of the valley floors, are used extensively for fattening cattle for the butcher. It is worth while looking at each of these forms of stock farming a little more closely.

Stock rearing involves both cattle and sheep. The cattle now kept are chiefly Dairy Shorthorns. Those reared are mainly dairy heifers drafted when ready into dales herds or sold into lowland dairy districts, which do not rear sufficient heifers to replenish their own herds. Such districts are South Cheshire, the Fylde, and the grass farms of the industrial Central Pennines: urban cow-keepers in Liverpool also buy in dairy stock from Craven and neighbouring dales and many Liverpool cow-keepers are themselves dalesmen by birth. Specialist dairy farms, especially in urban and suburban districts, frequently keep cows only when 'in profit', that is, in milk, and when they go dry they are sold either to the butcher for cow-beef or to a hill farmer, who keeps them cheaply until they are due to calve again and to return to lowland dairy farms. The sample of parishes in Craven given in Appendix B exhibited in 1936 a greater number of cows and heifers in calf than in milk, and, though the proportion of in-calf cows is not so high, the same feature is also prominent in lower Lonsdale.[1] The sheep flocks are partly Scotch Blackface, but this has been decreasing in relative importance; partly pure Swaledale, which (though in the Lake District considered less hardy than the Herdwick), as a local breed, is equally well adapted to the severe winter of the fells; and partly Masham, which is adapted to those dale farms with a substantial acreage of improved grass. The object, whatever the breed, is the production of store lambs for export to be fattened in lowland districts, the Swaledale on grass and the Masham on arable crops.[2] The pure-bred Swaledale lives on the fells the year through, but the crosses winter and lamb in the dales and summer only on the upland fescues.[3]

Dairying in the limestone dales is of an extensive kind. This is neatly shown by Farm A in Table XXVI. The returns of this table refer to the period prior to the Milk Marketing Board. Farm A is in a remote dale, Farm B in the vicinity of the town. The output per cow is less on Farm A than on Farm B, but it is only maintained on Farm B by heavy expenditure on purchased food. Proceeds were high on Farm B and low on Farm A, as milk was sold retail and wholesale respectively. Production for liquid consumption, however, is practised chiefly in the less remote parts of the dales; those in easiest contact by rail or road with consuming centres, but it has extended even during the late war. In Wensleydale much of the

[1] Of two sample farms, in early summer 1939, one had 23 cows in milk, 8 heifers in milk, 15 cows in calf, and 4 heifers in calf; the other farm had 35, 5, 10, and 8 respectively.

[2] Ruston, in *Regional Types of British Agriculture*, p. 78.

[3] K. B. Cumberland, 'Livestock Distribution in Craven', *Scottish Geographical Magazine*, vol. 54 (1938), p. 86.

milk is made into cheese, the market for which is a local Yorkshire one. On the more remote dales farms whose milk production is used mainly in feeding calves, the surplus milk is made into butter. The upper part of Wensleydale, with no arable and a substantial acreage of rough grazings, has more sheep than cattle and only a moderate stock density. Lower Wensleydale, with a light turnip and barley soil, had in 1936 about one-fifth of its acreage in arable and the parishes in the centre of the dale have little rough grazing. Summer sheep density is only a little less than in Upper Wensleydale, but the cattle density is substantially higher. K. B. Cumberland worked out for Craven the same point, that sheep increase and dairy cattle decrease with the proportion under rough grazings.

TABLE XXVI

Costs of Dairying on Two Farms in Yorkshire

	Farm A	Farm B
	£ s. d.	£ s. d.
Cost of upkeep per cow per annum in food and labour	20 0 0	48 10 0
Cost per gallon of milk	0 0 8½	0 2 0½
Proceeds per gallon of milk	0 0 11½	0 2 9
Profit per gallon of milk	0 0 3	0 0 8½
Profit as per cent of production cost	35	36
Yield per cow per annum in gallons	522	672

From A. G. Ruston, *Year Book of the Lancashire County Milk Recording Society*, 1931. These are the averages for 1920–30.

In the lower parts of the dales—Lonsdale, Craven, Ribblesdale, Wensleydale, Teesdale, and the rest—cattle are fed for the butcher wherever the alluvial holmes on the valley floors broaden out sufficiently. These fattening cattle are usually bullocks of the beef breeds, 'black pollies' as the farmers call them, the black-polled Aberdeen-Angus and Galloway, but Shorthorn bullocks and heifers are also grazed. Many farms and many parishes had in 1939 as many fattening beasts as dairy cows, and some had more. These beasts are bought in the autumn and, being by this time acclimatized, grow rapidly with the spring flush of grass. Many, if not most, are ready at two and a half years old before the end of the summer and before low prices set in in autumn with the glut of summer-grazed cattle on the markets.

Northumberland, south of the Merse of Berwick and its outlier in the Till Valley, is a region mainly in grass before the war, though there was still a substantial acreage in arable on many farms. A sample of farms in 1945 had 44 per cent of their acreage in arable.[1] The arable is focused on the lighter soils and the heavy boulder clay

[1] I am indebted to Mr. D. H. Dinsdale for these returns.

of the coastal zone is now grassland, though the soil is suited to wheat. The climate is cool and the seasons late, the accumulated temperatures being lower than in the Lothians farther north, and the corn harvest being commonly in September. The clays are deficient in phosphates and the low rainfall makes the development of a good grass sward difficult. Some parts of the district were becoming poor arable until the experiments at Cockle Park devised means of developing good grassland on these soils by the use of basic slag, a by-product of steel-making on the North-east Coast. This has been so successful that much indifferent land has been converted into good, if not first-class, pasture.[1] The best land will fatten three head of cattle on 4 acres and will carry also some stores for fattening the next summer and some sheep (one ewe to 1½ acres) as well: the average land will fatten one per 2 acres and carry stores and sheep in addition.[2] This is a high density for a district in eastern England. Farther west, apart from outliers on valley floors, the land is of poorer quality and is not improvable to the same standard. The proportion in rough grazings increases steadily westwards until on the Cheviots it takes up practically the whole of the acreage, apart from a few fields of improved land near the farm steading. Three zones may therefore be distinguished—the coastal zone of good permanent grass, which is a feeding district; the Cheviot zone of rough grazings, which is sheep country grazed by Cheviots and Blackface; and the intermediate zone with grass of good, indifferent, and poor quality. A sample of parishes in the coastal zone, almost wholly in grass, had a density in 1937 of fifty-eight stock units per 100 acres (a unit being a cow in milk), but a sample of moorland parishes, almost wholly in rough grazings, ten units per 100 acres.[3] The one had mainly cattle, the other mainly sheep. The contrast in balance of stock, as well as in density, is striking. There is, of course, a great difference between the two areas in earning value of land as measured by rents, rents on the coastal plain being 22–26*s.* per acre and on the Cheviot 3*s.* 6*d.* to 4*s.* 6*d.* per acre,[4] a ratio of approximately 6 : 1. The ratio of stock units is also approximately 6 : 1, and

[1] The stocking of the Cockle Park farm increased from 78 cattle and 180 sheep in 1898–1900 on 400 acres to 126 cattle and 266 sheep on 460 acres in 1936–8. In the early period the stock were in store condition, but they are now mostly sold fat. The increase in food-producing capacity must be at least of the order of 50 per cent (*Guide to Cockle Park Agricultural Experimental Station* (1939), p. 11). Most of the Northumberland coastlands are classed as third-grade rye grass by the Grassland Improvement Station.

[2] J. A. Hanley, A. L. Boyd, and W. Williamson, *An Agricultural Survey of the Northern Province* (1936), p. 34. A sample of farms in 1945 had fattening cattle and sheep as their dominant stock: they bought stores and sold fat. They had an average of only seven cows per farm.

[3] A small sample of moorland farms in 1945 had an average acreage of 1,962 (94 per cent rough grazings) a lambing percentage of 85 per 100 ewes, and a sale in the autumn of nearly two-thirds of the lambs.

[4] Hanley, Boyd, and Williamson, op. cit., pp. 26 and 32.

where the Guernsey cow is kept, as in West Cornwall, and there is some feeding of fat beasts for local consumption. Table XXVII displays the differences between the main dairy breeds in proportion of fat and in size of fat globule. The suitability of Jersey and Guernsey milk for butter-making is clear.

TABLE XXVII

Composition of Milk according to Breed of Cow

	Jersey	Guernsey	Ayrshire	Shorthorn	Friesian
As percentages of whole milk:					
Water	85·27	85·45	87·10	87·43	88·01
Fat	5·14	4·98	3·85	3·63	3·45
Solids-not-fat . .	9·59	9·57	9·05	8·94	8·48
	100·00	100·00	100·00	100·00	100·00
Ratio of solids-not-fat to fat	1·86	1·92	2·35	2·35	2·46
Percentage of fat in globules of various sizes:					
Small	11·4	11·4	34·3	*	38·6
Medium . . .	56·8	62·9	59·4	*	61·4
Large	31·8	25·7	6·3	*	—
	100·0	100·0	100·0		100·0

From W. L. Davies, *The Chemistry of Milk* (1939).
* Not available.

III

REGIONAL VARIETIES OF GRASSLAND HUSBANDRY: WALES

Wales is pre-eminently a grassland country, but arable is not by any means absent in the lowlands, and in the western peninsulas and coastlands even in 1939 it took up approximately a quarter of the total area and a third of the improved land. In the uplands, however, only minute patches are under the plough. In this arable, rotation grass takes a prominent place and the long ley is universal. In the aggregate, adding together permanent grass, rotation grass, and rough grazings, grass took up some 86·1 per cent of the area in agricultural use. The work of the Welsh Plant Breeding Station has been taken up chiefly with herbage grasses, just as that of the Plant Breeding Institute at Cambridge, located in eastern England, has been concerned mainly with cereals. A good deal of information, therefore, is available on the distribution within Wales of the several types of grassland[1] and of their relative productivity under Welsh conditions.[2]

[1] *A Survey of the Agricultural and Waste Lands of Wales*, ed. by R. G. Stapledon (1936).

[2] *Welsh Journal of Agriculture* and the *Bulletins of the Welsh Plant Breeding Station.*

In lowland Wales the dominant factors of climate affecting grassland are the long growing season and the heavy rainfall. Both tend to give quantity of growth. But the yield of hay in Wales is below that in England. This is due partly to the shallowness of Welsh mountain soils, but largely to the slower tempo of farming in Wales. Welsh farms have an abundance of labour, but a scarcity of capital; land is insufficiently drained and insufficiently fertilized.[1] The greater part of agricultural Wales is situated away from centres of consumption and Welsh grass farming is concerned largely with the initial phases of live-stock production, with rearing rather than with fattening or dairying. A relatively extensive system of grass farming naturally results. On account of the heavy rainfall the quality of the grassland is not of a very high order. The soils are strongly leached and usually exhibit a shortage of lime.[2] Even good fatting pastures in Wales are much lower in calcium, though higher in nitrogen, than similar pastures in England.[3] Nevertheless, owing to the rarity of quartzites, podsols are not of frequent development, and Prof. Robinson classifies many of the freely leached soils as brown earths, a condition encouraged no doubt by the alternate husbandry.[4] Owing to the heavy rainfall, soils with impeded drainage are frequent, especially in West Wales, and Robinson goes so far as to place 'more than half of the area' in this category. Drainage impedance, however, is seasonal rather than permanent.[5] These edaphic conditions cause a rapid deterioration in the quality of the herbage as judged by its botanical composition. Except where encouraged by suitable manurial treatment, the better grazing grasses tend to recede and the poorer to become dominant.[6] Returns of cattle fattening in Wales in the summer of 1935 over a large sample of farms give a daily live weight increase of 1·52 lb., but concentrates were fed in addition to grazing. The concentrates were sufficient to produce a live weight increase of one-half to two-thirds of 1 lb. daily, which leaves a live weight increase from grazing alone of under 1 lb. daily.[7] This is about half the live weight increase from grazing on the Lias pastures of the Market Harborough district.

Table XXVIII gives the yield, both the total annual yield and the

[1] J. Pryse Howell, 'Productivity and Income Yield of Small Holdings and Farms', *Welsh Journal of Agriculture*, vol. XII (1936), pp. 56–7.

[2] Rice Williams, 'The Growing Danger of Lime Depletion in Welsh Soils', *Welsh Journal of Agriculture*, vol. XIII (1937), pp. 246–55. See also Rice William, 'Some Fertility Data', *Welsh Journal of Agriculture*, vol. XVI (1940), pp. 132–43.

[3] W. G. D. Walters, 'Note on the Mineral Content of Some Typical North Wales Pastures', *Welsh Journal of Agriculture*, vol. IX (1933), pp. 109–15.

[4] G. W. Robinson, 'The Soils of Wales', *Guide Book: Third International Congress of Soil Science* (1935), pp. 263–9.

[5] Robinson, op. cit., pp. 271–2.

[6] Examples are given for Bangor and Anglesey in *Welsh Journal of Agriculture*, vols. V and X (1929 and 1934).

[7] J. H. Smith, 'Costs of Feeding Cattle', *Welsh Journal of Agriculture*, vol. XII (1936), pp. 117–18.

TABLE XXVIII

Grass Yield from Different Types of Grassland in Wales, 1929–30

	Good permanent grass	Poor permanent grass	Hill intake	Open hill grazing	*Molinia*
Percentage of yield from:					
Rye-grass group . .	48·5	23·9	7·8	—	—
Agrostis group . .	21·3	50·4	37·7	50·0	20·5
Others	30·2	25·7	54·5	50·0	79·5
Total . . .	100·0	100·0	100·0	100·0	100·0
Yield in cwt. per acre:					
Annual total . . .	46·4	22·6	20·4	11·2	13·2
May	7·2		4·6		2·1
June	8·1		3·4		3·0
July	3·6		3·9		4·8
August	8·5		1·4		1·3
September . . .	2·0		1·8		1·1
October to April . .	6·3		0·9		0·9

From W. Davies and T. E. Jones, 'The Yield and Response to Manures of Contrasting Pasture Types', *Welsh Journal of Agriculture*, vol. VIII (1932), and, for the Molinia sample, from W. E. J. Milton, 'The Effect of Controlled Grazing and Manuring on Natural Hill Pastures', *Welsh Journal of Agriculture*, vol. X (1934). Molinia returns are for 1930–1. Control plots only have been used in the compilation of the above table.

seasonal monthly yield, for several types of grassland in Wales. The good and the poor permanent grass were in the lowlands, and may be considered as belonging to the *Agrostis*-rye grass and to the *Agrostis* types respectively. The hill intake lies below the moor wall and is known as *ffridd*; it may be described as *Agrostis*-fescue. The open hill grazing is chiefly fescue and the *Molinia* pasture consists of *Molinia* and *Nardus* with fescues subordinate. The order of these types in respect of total annual yield is the same as their order in respect of botanical composition, with the exception that the *Molinia* type may have as high a yield in bulk as a fescue pasture though its feeding value is lower and its palatability to stock very much lower. The good permanent grass gives a higher annual total because of the longer growing season of the rye-grass group of grasses. The *Agrostis* group may yield as much as the rye-grass group during the flush in May and June, but the second growth in August is much less marked, and there is very little growth after August and prior to May.[1] Haymaking in these lowland meadows is usually in July, after the first flush has been completed; July hay has approximately the same feeding value under Welsh conditions as June hay and is

[1] W. Davies and T. E. Jones, 'The Yield and Response to Manures of Contrasting Pasture Types', *Welsh Journal of Agriculture*, vol. VIII (1932), Table VIII, p. 185.

superior to August hay.[1] The hill fescues have a second growth in September instead of in August, as at lower altitudes, but they have even less growth in winter and spring than the *Agrostis* group. The total bulk of growth of the hill fescues, of course, is less than that of the *Agrostis* pastures. *Molinia* may yield as much bulk as the hill fescues, but its growth period is very short; the shortest of all types. It reaches its maximum in July, and there is little growth after this date. These types of grassland thus vary in length of growing season as well as in gross nutritive value, and they are arranged in the same order in both respects.[2] The main object of stock-keeping on Welsh grass is the rearing of cattle and sheep to be exported from Wales as stores for fattening in England. Sales of live stock (together with wool) before the war amounted to approximately half of total farm sales. Some young store pigs, particularly in North-east Wales, are also exported for fattening in English cheese-making districts, but this is a very minor objective of Welsh farming. Export of stores to England is more marked from North and Mid-Wales than from South Wales, for South Wales has a large industrial and urban population of its own. The reasons for this concentration of attention on stores are partly economic: the removal from centres of consumption, the abundance of labour on Welsh farms for rearing stock, and the lack of capital for the purchase of adult beasts. The reasons are partly physical also: the scarcity of fatting pastures in Wales for summer fattening and the scarcity of sufficient arable feed for winter fattening. Welsh farmers have plenty of grass good enough to produce beasts that are 'half fat' or even 'three-quarters fat', but only occasional fatting pastures are good enough to fatten without concentrates.[3] They have usually enough arable feed and grass foggage to carry beasts through the winter in a store condition. This raising of stores is practised in both upland and lowland, but, of course, much more uniformly in the upland, where the quality of the grazing and the quantity of the arable feed are usually inadequate for any other purpose. The upland as well as the lowland farms rear both cattle and sheep, though cattle are absent from the higher sheep-walks at altitudes of 1,500 feet and over.

The breed of cattle kept is the Welsh Black,[4] and, on the eastern margins of the upland, the Hereford or Hereford cross, when intended for the production of store bullocks, and the Shorthorn, when intended for the production of dairy heifers. Some Shorthorn bullocks are also reared as stores. The traditional system of calf-

[1] C. B. Jones, 'The Feeding Value of Meadow Hay cut at Different Dates', *Welsh Journal of Agriculture*, vol. XIV (1938), pp. 75–92.

[2] For the distribution of these types of grassland the reader is referred to R. G. Stapledon (ed.), *Survey of the Agricultural and Waste Lands of Wales* (1936).

[3] T. Lewis, 'The Marketing of Cattle in Wales', *Welsh Journal of Agriculture*, vol. IX (1929), p. 39.

[4] In the Bala cleft route across the Welsh upland the Welsh Black predominates from Bala westwards, but there are very few around Corwen.

rearing was by suckling and not infrequently extra calves were bought in, each cow suckling two calves during the grazing season.[1] One cow per calf was a rule with the beef breeds, the Shorthorn alone giving sufficient milk for two calves. The cows calve in spring under this system and calves are not weaned until the close of the grazing season; when the cows are housed in winter they are dry and their food requirements small, consisting only of maintenance, with a small allowance for the growth of the foetus prior to the next calving in spring. The labour costs of this system are very low. The commoner system of store raising, particularly on the lowland farms, is to milk the cows and feed to the calves a ration partly of whole milk and partly of separated milk, the residue from butter-making. Store-raising and butter-making go hand in hand and are standard activities of the average Welsh farm.[2] Milk from Welsh cattle has a high fat content, higher than that from the dairy breeds, with the single exception of Channel Island cattle.[3] On a sample of sixty-six farms the number of cows kept per farm was 9·6, the number of calves reared annually was 10·1, and the amount of butter made weekly per cow was 1½ lb. in winter and 4 lb. in summer.[4] The young stock are sold off the farm in spring for fattening on grass, when one or two years old, or in autumn for fattening in arable yards, when one and a half or two and a half years old.[5]

This system of store-raising and butter-making has been profoundly modified by the growth of the liquid milk market and by the increase in the radius from which milk wholesalers have drawn their supplies. The movement was in progress before the creation of the Milk Marketing Board, and it has been accelerated by its operations. In 1933–4 the gallonage of milk sold under wholesale contracts in Wales was 38·5 million, in 1935–6 55·4 million, in 1937–8 63·7 million, and in 1938–9 71·2 million. It has been due

[1] S. T. Morris, 'Cattle-raising in Radnorshire', *Welsh Journal of Agriculture*, vol. x (1934), pp. 108–26.

[2] '. . . the butter and store-stock system . . . was certainly the most widespread in the Principality down to the First World War, and survived in the remoter districts throughout the inter-war period' (A. W. Ashby and I. L. Evans, *The Agriculture of Wales and Monmouthshire* (1944), p. 56).

[3] W. L. Davies, *The Chemistry of Milk* (1939), p. 23, quoting Tocher.

[4] E. Ll. Harry, 'Milk Selling and Cattle-raising in Wales', *Welsh Journal of Agriculture*, vol. XIII (1937), Table IX. The butter would require 3·6 gallons of milk in winter and 9·7 gallons in summer. i.e. approximately 1·4 gallons per cow per day in summer. If the cows in summer produce 2 gallons of milk daily, then the amount fed to calves would be 0·6 gallon whole milk and 1·4 gallons separated milk. Separated milk has half the feeding value of whole milk so that in whole milk equivalents the calves would be fed $0{\cdot}6+\frac{1{\cdot}4}{2} = 1{\cdot}3$ gallons daily. The practice was to feed 1½ to 2 gallons of whole milk at first and to change over gradually to separated milk and calf meals.

[5] Morris, op. cit., p. 123. From a sample of fifty farms in the Vale of Radnor in 1930, 690 head of cattle were sold, of which 510 were stores and 145 fat stock. The stores were made up of 325 yearlings, 107 two-year-olds, and 78 store cows. Of the yearlings, 176 were sold in the spring and 149 in the autumn.

only in part to an increase in the number of dairy cows, for these grew between 1933 and 1939 by only 1·8 per cent, and only in part to an increase in the output of the previously established dairy farmers. The greater part of the increase has been due to stock-raisers and butter-makers diverting their milk into the liquid market, a diversion due to the greater profits to be obtained even though the milk was ultimately used for factory manufacture.[1] Those farmers who obtained skimmed milk from butter-making factories reared almost as many calves as formerly per farm, though not per cow, but those who did not obtain skimmed milk reared only half as many calves as previously.[2]

In the uplands the sheep are of native upland breeds. In the lowlands the mountain breeds are also present and even predominate in the Welsh districts of West Wales, but the lowlands have many cross-bred sheep, and these, as in Pembroke, may outnumber all others.[3] In the lowlands the practice is to use rams of down breeds in order to secure early lambs. The objective of sheep farming in the uplands is the maintenance of the hill flocks, the drafting of store lambs to the lowlands, and the production of wether mutton: the objective in the lowlands is the feeding of upland store lambs and the production of early Welsh lamb. The uplands raise stores, the lowlands fatten as well as breed. The only sheep that the uplands can produce ready for the market are wethers two or three years old. Changes in taste have substituted lamb for mutton in the consuming markets, and there is now little demand for wether mutton. In 1893 the four counties of Merioneth, Carnarvon, Radnor, and Brecon, had more 'other sheep over 1 year' than ewes, but in 1939 these were at most only one-third of the ewes,[4] to such small dimensions has the wether flock shrunk. The usual practice of the hill farmer with a mountain sheep-walk, which can winter less than half its summer carrying capacity, is to 'board' out his young stock during the winter on a lowland farm, such young stock being returned to the mountain in the spring. As will be readily recognized, the system is a form of inverted transhumance. There is the same inverted transhumance in the Lake District. The farms which winter lambs and the weaker ewes from mountain sheep-walks are usually coastal hillside farms of the Lleyn Peninsula, of Ardudwy in Merioneth, and especially of the coastal plateau of North Cardigan, or, for the inland sheep-walks,

[1] The quantities of milk handled by the Board which were used for manufacture were more than trebled in North Wales and more than doubled in South Wales between 1933–4 and 1938–9. The proportions manufactured in 1938–9 were 54 per cent in North Wales and 39 per cent in South Wales (Ashby and Evans, op. cit., p. 62).

[2] Harry, *Welsh Journal of Agriculture*, vol. XIII (1937), Table IX.

[3] J. G. Williams, 'Changes in the Sheep Population of Wales', *Welsh Journal of Agriculture*, vol. VI (1930), pp. 116–29.

[4] E. Ll. Harry, 'Some Aspects of the Sheep Industry in Wales', *Welsh Journal of Agriculture*, vol. XV (1939), pp. 133–4.

the hillside farms along the eastern foot of the Black Mountain, Radnor Forest, and the Berwyns. Sheep move downhill in early October and are grazed on the stubble until the fogged pastures are ready and until the cows are housed indoors. Very good winter keep is not necessary, as lambs would thereby be incapacitated for subsistence on poor mountain grazings the following summer. They return to the mountain during the period from mid-April to mid-May, first the yearlings and then the ewes, gradually moving up to higher and higher land. In the case of high and late mountain grazings, such as those of Snowdonia, sheep may not reach them until the beginning of July.[1] The usual charge in Mid-Wales for this lowland wintering was in 1935 approximately 6*s*. per head for the period mid-October to mid-April.[2] This charge is almost as much as the annual rent per acre of the sheep-walk. Although apparently profitable to the lowland farmer, the system involves adjustments to his grazing policy. Haymaking is late, as the grass cannot be put up for hay until the beginning of May, and little of the aftermath can be grazed for the second growth has to be conserved in order to provide foggage for wintering lambs. It has been demonstrated on the land farmed under the Cahn Hill Improvement Scheme that lambs can be wintered in the uplands, not on exposed sheep-walks, but on rough grazings of approximately 1,000 feet in altitude, when the lambs have daily access for a few hours to temporary pastures of rye grass or timothy.[3] Experiments have also been conducted on the fattening of lambs on sown crops and on rape and a live weight increase in winter of 9·5 lb. a month was obtained, representing 0·3 lb. a day, which is an average rate of summer growth for mountain breeds.[4] Under these conditions lambs can continue to grow steadily in winter as well as in summer. It will be noticed that both these improvements in the carrying capacity of Welsh uplands are due to sown crops.[5] The lowland farmers themselves keep breeding flocks as well as winter lambs for hill farmers. Their own breeding flocks are designed for fat-lamb production from mountain or cross-bred ewes and Down rams. This gives the early high quality lamb which the urban market requires. A substantial number of lambs are sold before the date (June 4) of the annual agricultural returns, amounting to probably

[1] E. Davies, 'Sheep Farming in Upland Wales', *Geography*, vol. xx (1935), pp. 97–111.

[2] M. Griffith and P. M. G. Hutton, 'The Wintering of Sheep on Temporary Grasses', *Welsh Journal of Agriculture*, vol. xi (1935), p. 124. The scale of payment has varied greatly, ranging from 3*s*. 6*d*. to 5*s*. prior to 1914, to 10*s*. to 12*s*. in 1924 (E. Davies, op. cit., p. 102).

[3] Griffith and Hutton, *Welsh Journal of Agriculture*, vol. xi (1935), pp. 121–5, and vol. xii (1936), pp. 126–30.

[4] Griffith and Hutton, *Welsh Journal of Agriculture*, vol. xii (1936), pp. 120–5.

[5] For the whole problem of hill sheep farming see *Report of Committee on Hill Sheep Farming in England and Wales* (1944), Cmd. 6498.

over 10 per cent in the case of Anglesey and Pembroke.[1] Fully 50 per cent are sold by the end of the year.

TABLE XXIX

Stock of Different Types of Farms in Wales, 1936–7

	Cattle and Sheep Farms		Mixed Farms	Cattle and Milk Farms
	Poor land	Good land		
Rent per acre	*7s. 5d.*	*17s. 8d.*	*25s. 4d.*	25s
Average acreage	265	210	101	120
Stock per farm:				
Dairy cows	9·1	9·2	13·7	19·6
Other cattle	23 7	34·9	24·5	19 8
Breeding ewes	167·2	135·0	52·9	41·6
Other sheep	90 1	103·4	41·2	23·4
Total animal units:				
Per farm	57·0	63·4	52 0	47 4
Per 100 acres	21 5	30·2	51·7	39·6
Receipts per farm (£)				
Cattle	194	470	289	241
Milk	49	54	234	543
Milk products	40	17	12	2
Sheep and wool	203	376	149	124
Other stock and stock products	131	198	717	243
Crops	4	36	32	42

From J. Pryse Howell, 'Recent Financial Results of Different Types of Farms in Wales', *Welsh Journal of Agriculture*, vol. XIV (1938). The animal unit is 1 cow. The first two categories are upland farms with rough grazing, the last two lowland farms without rough grazing. The first category has more rough grazing than improved land, the second more improved land than rough grazing, and it has usually a better-placed and more convenient farm steading. The differences between the third and fourth categories are economic rather than environmental, and due to differences in stock economy. See Ashby and Evans, *The Agriculture of Wales and Monmouthshire* (1944), Chapter IX.

To conclude this account of grass farming in Wales it will be useful to examine particulars for four types of farms:[2] upland farms on poor land, upland farms on good land, lowland mixed farms,[3] and lowland dairy farms. The upland farms are larger than the lowland, but they carry fewer live stock per acre and pay a lower rent per acre, though they have a not dissimilar number of stock per farm. Equated as grazing units, the most important stock on the poor upland farms are sheep; on the better upland farms, cattle

[1] J. G. Williams, 'Changes in the Sheep Population of Wales', *Welsh Journal of Agriculture*, vol. VIII (1932), pp. 66–7.

[2] J. Pryse Howell, 'Returns for 1930–1 to 1937–8', *Welsh Journal of Agriculture*, vols. XIII–XV (1937, 1938, and 1939).

[3] These are not mixed farms in the sense that they have substantial arable as well as grass. They are mixed in the sense that they do not specialize on any one branch of stock husbandry.

(particularly young cattle) equally with sheep; on the dairy farms, dairy cows; and on the mixed farms no particular class of stock predominates. It will be noticed that the farm income is derived almost wholly from live stock and live stock products, the upland farms selling mainly live beasts with little butter and milk, the lowland mixed farms selling milk equally with stock, and the dairy farms selling primarily milk.

IV

REGIONAL VARIETIES OF GRASSLAND HUSBANDRY: SCOTLAND

The management of improved land in Scotland presents substantial differences from practices common in the English Plain. In the English Plain arable and permanent grass are sharply distinguished: the grass is really permanent, not having been ploughed for generations (except for the sporadic but increasing development of ley farming), and grass in rotation is usually left down for one year alone. In Scotland the practice is more comparable to that of Cornwall or of West Wales, grass being in a long ley and rarely permanent. The difference is in part a relic of old practices, but both ancient and modern management issue out of differences in the physical environment between the English Plain on the one hand and western and northern Britain on the other. The English Plain is made up of belts and patches of soil of markedly different character, stiff clays alternating with light sandy and chalky loams. Light loams in a dry climate cannot develop a good grass sward and only low-lying clays close to the water-table and themselves retentive of moisture are capable of growing good grass. In western and northern Britain most soils are intermediate in texture and the sharp distinction between very light and very heavy soils is much less common. Soils derived from Palaeozoic shales in the west and north are not as heavy as the Mesozoic and Tertiary clays of the south-east. The light loams of Scotland are not so dry as the light loams of the English Plain because of the higher effective rainfall, consequential on lower temperatures, and even on these soils the general rule is a ley of two to three years. The greater part of the improved land in Scotland, as in Cornwall and parts of West Wales, is in alternate husbandry, cropped for a few years in arable, and then laid down to grass for a varying term of years. When newly laid down, the farmer returns this grass as in rotation, but when several years old he may return it as permanent grass, even though it will be ploughed in due course in order to renovate the sward. Under these conditions rough land with ribs of bare rock protruding from beneath the soil may be ploughed, cropped, and then laid down to grass. I have observed such land in Galloway. On light soils the length of the ley may be short, but on heavier soils it may be ten years or more.

In Scotland only one-third of the improved land was in 1939 returned as being in permanent grass, though another third was in rotation grass, making in all two-thirds of the improved land in grass. In England some 60 per cent of the improved land was returned as permanent grass and some 10 per cent as rotation grass, making in all just over two-thirds of the improved land in grass. The net result is therefore similar, but the grass is unequally distributed in the two countries between permanent and temporary.

The distribution of grass within Scotland, however, varies as between east and west. As in England and Wales, grass takes up a larger proportion of the improved land in the west than in the east, and for the same reasons. This is especially the case with grass returned as permanent, but it is also true of grass returned as in rotation. As a percentage of the total arable, grasses in rotation are least important in the Lothians and Fife and most important in Galloway, Dumfries, and Ayrshire. This greater importance of permanent and of rotation grass in the west is true only of the western part of the Central Lowlands and of the South-west (Galloway and Dumfries). It is not true of the Western Highlands, where crops occupy as large an acreage as permanent and rotation grass combined, but it must be remembered that in the Western Highlands the improved land occupies only a minute fraction of the total surface. It is, therefore, only in the western Central Lowlands and in the South-west that there are lowland grass districts comparable in character to those of England and Wales. The Southern Uplands, the Highlands, and some of the uplands within the Central Lowlands, are in rough grazings and are comparable to upland Wales and the Pennines. The quality of the grass in this lowland grassland region, judging from its botanical composition, is not of a very high order. Ayrshire is comparable in this respect to West Wales. In such a moist, cool climate with a tendency to soil acidity[1] the botanical composition of the herbage, as in West Wales, is likely to deteriorate: it is recognized by the practice of the long ley that pastures require occasional reploughing and reseeding in order to restore their quality. The stock-carrying capacity provides useful additional information of quality of grass. The number of stock units, the unit being a cow in milk, in the Kilmarnock and Newmilns district of North Ayrshire, to give a specific case, works out at approximately 50 to 100 acres of grazing.[2] The usual rate of stocking on the heavy

[1] Four North Ayrshire soil types exhibit the following pH measurements: heavy sand, 5·5; light sand, 6·0; heavy loam, 5·5; light loam, 6·0 (*The Geology of North Ayrshire* (1930), Geological Survey).

[2] This is for the district as a whole: individual parishes and farms will show better figures. I have eliminated the acreage put up for hay from the grass, and the rough grazings have been reckoned at one-fifth of the grazing capacity of the permanent grass. All grazing stock have been included and have been equated according to their approximate grass consumption. The calculation, of course, is only an approximate one as, without local field work, only approximate information

loams of North Ayrshire, the most widespread soil type of the district, 'the characteristic type of the boulder-clay lowlands floored by Carboniferous sediments', is two acres of pasture per cow.[1] The agreement with the calculation of stock units is close. This evidence is again indicative of grazing of medium quality. It is probably of a similar quality to the grazing of the lowlands of West Wales.

The utilization of this grassland in Ayrshire is similar to that in the dairying districts of England in the sense that the dairy cow is the dominant beast, amounting in North Ayrshire to over half of the total stock units. In the dairying district of the Fylde, in Lancashire, cows and heifers in milk and in calf accounted in 1934 for 12,085 grazing units out of a total of 18,456. The fattening of cattle and of sheep, the dominant objective of stock husbandry in the arable districts of eastern England, and, up to a point, of eastern Scotland, is in Ayrshire, as in other dairying districts, only a minor objective of stock farming, and it is practised chiefly on farms with a high proportion of arable. Some sheep are kept on the dairy farms, but, as in other dairying districts, mainly in winter and spring, when dairy stock are housed indoors. Being a relatively small beast in the same yield group as the larger Shorthorn,[2] the Ayrshire is an economical milk producer, but it is of little use for beef and the bull calves are of very little value. An Ayrshire-Shorthorn cross has become popular in recent years as the bullocks possess some of the beef qualities of the dual-purpose Shorthorn and the heifers of this cross, bred in Ayrshire[3] and South-west Scotland, are now common in the dairy herds of North-west England. The Ayrshire is capable of living on relatively poor land and in a relatively harsh climate; it is, therefore, the antithesis of the Jersey as a dairy breed. The greater part of the milk production of Ayrshire used to be made into cheese, the milk of the Ayrshire cow being more suitable for cheese than for butter (see Table XXVII), and Ayrshire itself being relatively remote from large centres of liquid milk consumption. Dairy farms in Renfrew and Lanark in the lower Clyde Valley were then able to supply the industrial West of Scotland. But the liquid milk market of these industrial districts now draws upon Ayrshire; the whole of Ayrshire in winter, but in summer North Ayrshire alone. In North Ayrshire the object of dairying is a level production winter and summer alike; in South Ayrshire production is focused into summer.[4]

is available of live weights, of live-weight increases, of milk production, and of foods fed additional to grazing. No allowance has been made in this rough calculation for concentrates fed, and in North Ayrshire these are substantial.

[1] *Geology of North Ayrshire*, pp. 383–4.

[2] This is the yield group for the purposes of the *Register of Dairy Cattle* of the Ministry of Agriculture.

[3] J. H. G. Lebon points out the high proportion of heifers in calf in the cattle population of Ayrshire, The Land of Britain, pt. 1, *Ayrshire* (1937), p. 65.

[4] A sample of herds in eastern Scotland in 1945–6 had an average yield per cow in winter of 286 and in summer of 346 gallons (*Report on Costs of Milk Production*

For Ayrshire as a whole, in 1934, just over 70 per cent of the total production was consumed by the liquid market: the rest was made into cheese, cream, and condensed milk, partly by factories (about 6½ million gallons) and by farmhouse cheese-makers (about 1½ million gallons). Farmhouse cheese-making is entirely a summer business, in Ayrshire as elsewhere, and all but 3·8 per cent of the milk used by farmhouse cheese-makers in 1934 was consumed in the six months April to September inclusive. The farmhouse cheese-makers are chiefly in the more remote districts of South and Central Ayrshire, the surplus of North Ayrshire being handled by creameries. In Ayrshire, as a whole, milk production begins to increase in March, as in South Britain, owing to spring-calving cows beginning their lactation. In England and Wales maximum production is reached in May and June, the output of these months being identical when allowance is made for the greater length of May, but production falls away rapidly in July. (See Fig. 29.) In Scotland maximum production does not come until June and, although it falls away in July, the decline is less than in England and Wales. The decline in South Britain is due to the burning up of pastures in July, but in the cooler climate of Scotland this is less likely to occur and the grazing is better maintained. These variations in Scotland as compared with England and Wales—a later maximum milk output and a better maintained output in July, are a function of the climatic differences between North and South Britain, climatic differences acting through the vehicle of grass.

In Galloway, except in Wigtown and in the Rhinns of Galloway, dairying is not such a dominant objective. The beef Galloway shares the lowland pastures with the dairy Ayrshire. Dairying is here intrusive and has been at the expense of the rearing of beef stores. There are no centres of liquid milk consumption nearby and milk is exported for long distances to industrial districts in the West of Scotland, and, formerly, to industrial districts in North-east England, Lancashire, and the Midlands,[1] either as cheese or butter or as whole milk. Milk churns from Stranraer used to be a common sight on railway platforms in Lancashire before the operations of the Milk Marketing Board. It has been estimated that in 1933 10½ million gallons were sent into England from South-west Scotland, but at the request of the English Marketing Board this export into England ceased.[2] The manufacture of milk is handled largely by creameries situated by the side of the railways and main roads. The whey is

(1947), Edinburgh and East of Scotland College of Agriculture). Corresponding yields in western Scotland were in winter 240 and in summer 348 gallons, a more pronounced seasonal variation (*Report on Milk Costing* (1947), West of Scotland Agricultural College).

[1] W. A. Gauld, 'Galloway and the Dales', in A. G. Ogilvie (ed.), *Great Britain: Essays in Regional Geography* (1928), pp. 462–3.

[2] *Report on Agricultural Marketing Schemes*, p. 23. Only one contract with English consumers continued to operate in 1934.

fed to pigs. Along the margins of the Southern Uplands and in the dales or glens within them a different type of husbandry is practised. The dairy cow is of little importance except for local farm and village requirements. The chief object of keeping cattle is the rearing of Galloway stores. The annual returns give as many calves as cows in milk, always an index of a rearing district, unlike the dairying districts where cows in milk exceed the number of calves, sometimes by as much as five to one. Even cattle-rearing is subordinate to sheep, and this is, of course, the dominant activity of the Southern Uplands themselves. On the uplands, hill breeds are alone found and ewes outnumber lambs, but on the margins of the uplands Half-bred ewes are also kept, and here lambs outnumber ewes, the lambing percentage of the ewe being over one per ewe whereas with the hill breeds it is under one per ewe.

The hill sheep farm of the Southern Uplands is highly specialized. It frequently consists entirely of mountain grazing except for a few fields around the farm steading; it carries few stock except sheep, a 2,000-acre holding having less than four horses and nine cows, these last being kept for calf rearing rather than for milk production. In the eastern part of the Southern Uplands a 2,000-acre holding will carry 950 ewes with their lambs and between 200 and 250 yearling sheep and wethers, that is, approximately 2,000 head of sheep of all kinds, or one per acre: these are average conditions in Berwick, Roxburgh, and Selkirk. In the drier eastern part of the Southern Uplands the landscape is of rolling 'grassy' hills, the better parts of which are *Agrostis*-fescue, the poorer *Nardus* with heather.[1] But in the wetter western part there is more peat bog and cotton grass moor. The better grasses are grazed by the Cheviot, the *Nardus* and heather by the Blackface. The flocks of the hill breeds remain on the hill the year through, but the carrying capacity during the winter is at best only half what it is in summer, 2–4 acres being required for each sheep in winter.[2] There is, therefore, an export of stock in the autumn in order to reduce it to the land's winter capacity. There is no evidence of a decline in the carrying capacity of the hill pastures of the Southern Uplands, as there appears to be of those of the Highlands,[3] though on general grounds it would appear that the same predominance of sheep grazing would be likely to lead to the same deterioration of pasture. The point is discussed further below in reference to the Highlands.

[1] R. Smith mapped the Pentlands as chiefly *Agrostis* with Yorkshire fog, the greater part of the Silurian hills of the Edinburgh district as *Agrostis*-fescue mixed with heather, and the basalt hills within the lowlands as *Agrostis*-fescue with some meadow grasses (R. Smith, 'Botanical Survey of Scotland, I,' *Scottish Geographical Magazine*, vol XVI (1900), pp. 406–10).

[2] W. G. Smith, 'Hill Pastures and Sheep Rearing' in A. G. Ogilvie (ed.), *Great Britain: Essays in Regional Geography* (1928), p. 474.

[3] *The Stock-carrying Capacity of Hill Grazings in Scotland* (Misc. Publications, no. 15, Department of Agriculture for Scotland (1938), p. 10).

The Highlands present a poorer, more impoverished environment than the Southern Uplands. The grassy slopes of the Southern Uplands represent, in fact, the better quality of hill grazing in Scotland. The Highlands attain higher elevations and are made up of older and harder rock series. The Western Highlands have also a heavier rainfall. The typical mountain plant associations are heather in the Central Highlands and the tough *Scirpus* in the Western Highlands,[1] the grassy slopes of the Southern Uplands being largely absent. Of the total area of the three Southern Upland counties of Peebles, Roxburgh, and Selkirk, only 4·5 per cent is agriculturally unproductive, but of the four Highland counties of Argyll, Inverness, Sutherland and Ross and Cromarty, fully 27·0 per cent is agriculturally unproductive.[2] In the Western Highlands most of the mountain grazing is at elevations of under 1,000 feet. While the carrying capacity of the hill grazings of the Southern Uplands is, in summer, one sheep per acre, in those parts of the Highlands given over to deer forests it is, in summer, one sheep per 5 acres,[3] though many Highland grazings are better than this. The total number of sheep of all ages and kinds in these four Highland counties, assuming them to be kept in June on rough grazings alone, works out at one sheep per 2·7 acres, or, if sheep in deer forests are included, one sheep per 3 acres. These sheep are kept on large sheep farms and on crofter's land alike. The average croft in two parishes in Sutherland had in the 'thirties 4 acres of improved land and a share of common hill grazing working out at 208 acres per croft. The crofts in the better townships each had an average of 21 ewes, 19 lambs, and 14 other sheep, the crofts in the poorer townships, 14 ewes, 12 lambs, and 7 other sheep. On such land the number of lambs born per 100 ewes is about 80 on the average, and this is sufficient to provide enough ewe lambs for the maintenance of the hill flock.[4] There has been a substantial decline in the sheep population of the Highlands, which for the five counties of Argyll, Perth, Inverness, Sutherland, and Ross and Cromarty, amounted to 22·7 per cent in the 1924–8, as compared with the 1871–5 period.[5] This reduction has been due almost entirely to a reduction in the number of wethers, the number of ewes and of lambs having remained fairly constant. It has been the higher grazings, the preserve of the wethers, that have suffered most. The number of 'other sheep, one year and above' (which includes the wethers) as a percentage of the number of ewes

[1] W. G. Ogg, 'The Soils of Scotland', pt. 1, *Guide Book: Third International Congress of Soil Science* (1935), pp. 180–3.

[2] This excludes deer forests from land in agricultural use except those parts of the deer forest which are grazed by cattle and sheep.

[3] *The Stock-carrying Capacity*, p. 4, quoting the Report of the Commission of 1883.

[4] 'Agricultural Surveys', *Scottish Journal of Agriculture*, vol. XIV (1931), pp. 151 and 154. A lambing percentage of over 65 is considered to be the minimum for the maintenance of the flock (*Scotland's Marginal Farms*, VI (1947), p. 17).

[5] *The Stock-carrying Capacity*, p. 1.

was 29 per cent for Scotland as a whole, but 56 per cent for the deer forests, which are on poor ground at high elevations. This decline, which has now ceased, has been attributed to many factors. Probably the largest single factor is the establishment of deer forests, themselves a response to the decreased value of the higher grazings consequential on the fall in the price of mutton. Other factors which have affected the situation are the spread of bracken, inadequate or unskilful burning of heather,[1] the deterioration in quality of pasture which results from the continued grazing by sheep alone, particularly when the sheep flock consists of ewes and lambs with their heavy demands on lime and phosphates. Wethers, like bullocks, take much less out of the soil. After a review of experimental evidence,[2] Dr. Fenton concludes that 'continuous sheep grazing over a very long period is one, if not the chief, cause of this spread of Mat Grass—and if this is true under the present system, then grazing must steadily degenerate'.[3] Fenton, however, is writing of the better hill grazings, where *Nardus* competes with *Agrostis* and sheep's fescue. It would appear, therefore, that the extreme specialization which characterizes the hill sheep farm of Scotland is resulting in some deterioration in the quality of the land. Grazing by cattle would help to check the deterioration, for cattle[4] graze coarse-leaved and fine-leaved grasses alike, and they can keep bracken in check by bruising the young fronds. Some Highland glens are now in process of improvement by such cattle grazing, by pure Highland and by Highland–Shorthorn crosses. The Macaulay Institute for Soil Research is experimenting with the improvement of lowland peat in Lewis by draining, manuring, and cultivating, and some of the methods developed for the improvement of hill grazings in Wales will no doubt be applicable, after modification, to Scottish conditions.

V

TYPES OF DAIRYING: SUMMARY

A brief analysis of regional variations in systems of dairy farming

[1] The questionnaire circulated on behalf of the Committee on Hill Sheep Farming in Scotland included inquiries on both bracken and heather (*Report*, Appendix XI (1944), Cmd. 6494).

[2] The experimental evidence refers mainly to Boghall Glen in Midlothian. Under sheep grazing *Nardus* expands at the expense of heather; when withdrawn from sheep grazing, heather expands at the expense of *Nardus*. When *Nardus* is fenced and cut regularly, an *Agrostis*-fescue association expands at the expense of *Nardus*; when grazed by sheep the *Agrostis*-fescue retreats before the *Nardus*. When Galloway cattle graze alongside sheep, *Nardus* retreats and the carrying capacity of the grazing is increased. These differences are most informative (E. W. Fenton, 'The Influence of Sheep on the Vegetation of Hill Grazings in Scotland', *Journal of Ecology* (1937), pp. 424–30).

[3] E. W. Fenton, 'Some Aspects of Man's Influence on the Vegetation of Scotland', *Scottish Geographical Magazine*, vol. LIII (1937), pp. 21–2.

[4] In calculating the number of stock a crofter is allowed to keep on common grazings a cow is reckoned as equal to six adult sheep (*Scottish Journal of Agriculture*, vol. XIV (1931), p. 151).

in England and Wales will serve to conclude this survey of grassland husbandry. The analysis refers to conditions prior to 1939: there have been many changes since in the absolute figures but regional differences persist. The regional variations in systems of dairying can be traced in a broad way from the reports on the *Costs of Milk Production in England and Wales* under the Milk Investigation Scheme, abstracted in Table XXX.

TABLE XXX

Regional Variations in Systems of Dairying in England and Wales, 1934–7

	No. of acres of permanent grass per cow *acres*	Yield of milk in gallons per cow per day			Increase of summer yield over winter *per cent*
		Summer *galls.*	Winter *galls.*	Year *galls.*	
North-west	3·0	1·91	1·63	1·77	18
West Midland	3·9	1·97	1·56	1·75	26
North Wales	3·4	1·96	1·69	1 82	16
South Wales	5·3	1 86	1·47	1 67	28
Far West	3 6	1·74	1·34	1·55	30
Mid-West	4·3	1·82	1·53	1 68	19
East	4·4	1·92	1·80	1·85	7
East Midland	4·6	1·83	1·67	1 76	9
South	4·3	1·75	1 73	1·74	1
South-east	4·0	1·85	1·69	1·77	10
North	4·2	1·97	1·75	1·86	13

	Cost of food per gall.			Annual cost of food per gall.			
	Summer *d.*	Winter *d.*	Year *d.*	Grazing *d*	Cake *d.*	Hay *d.*	Straw and roots *d.*
North-west	4 44	8·21	6 10	0 88	3·34	1·35	0·48
West Midland	3·72	7·75	5·57	0·99	2·82	1·30	0·39
North Wales	4·17	8·21	6 00	0·97	3·21	1·51	0·31
South Wales	3·84	8·35	5·77	1·49	2·64	1 46	0·19
Far West	3·85	8·81	5·88	1 32	2·72	1·16	0·67
Mid-West	3·76	6 83	5·15	1 22	2·06	1 43	0·46
East	4·14	6·99	5·40	0 63	3·02	0·88	0·85
East Midland	4·08	7·53	5·68	0 78	3 17	1 19	0·50
South	4·09	7·22	5 62	0·72	2·87	1·34	0·66
South-east	4 68	7·58	6·05	0·77	3·17	1·33	0 70
North	4·39	7·64	5·90	0 62	3·31	1·51	0 46

From *Costs of Milk Production in England and Wales* (Milk Investigation Scheme, Interim Reports nos. 1, 2, and 3 for 1934–5, 1935–6, and 1936–7 respectively). The above are unweighted averages for the three years for the farms which sell their milk wholesale. The regions are those of the Milk Marketing Board (see Fig. 48c). There have been subsequent changes in balance of summer and winter production and in balance of cake and arable feed.

The permanent grass is more heavily stocked in the west than in the east, due partly to the greater quantity of grass available in western districts. The importance of grazing is higher in every

western district, ranging as an average for the years quoted from 0·88*d.* per gallon to 1·49*d.*, as compared with a range in the east of 0·63*d.* to 0·78*d.* The importance of grazing is greatest of all in the south-west—in South Wales, the far-west (Cornwall and Devon), and the mid-west (Dorset, Somerset, and Wiltshire); in this warm maritime corner the grazing season is prolonged far into winter. As a percentage of total food costs, grazing is least in the northern and eastern districts (from Northumberland to Suffolk), which have bleak winters, late springs, and a low rainfall. Heavy stocking is due also to intensity of feeding with concentrates, the most heavily stocked districts (the north-west and North Wales) being among those which feed concentrates most heavily. In all districts concentrates were before the war mainly bought in, almost wholly so in districts other than the arable districts of eastern England and the far west with their stock food from arable land. The feeding of straw and roots is also most important in these same arable districts.

There is considerable variation from district to district in yield of milk per cow. As expressed in district averages, yield of milk per cow does not vary directly according to environmental factors expressed in terms of food, but varies rather according to the type of cow kept in the district.[1] Information on yield per cow is also available from the returns of the Milk Recording Societies and from the estimates of the reports on the *Agricultural Output* for 1925 and 1930–1. The order of the districts varies to some extent according to these different sources for the nature of the returns varies, being for a limited sample of cows whose yield is accurately known in the case of the returns of the Milk Investigation Scheme and of the Milk Recording Societies, but being estimates for the whole dairy herd in the case of the returns of the *Agricultural Output*. Taking the greatest common measure of agreement, it would appear that yield per cow is highest in the east and south-east and in the north-west, where good-quality Shorthorns and Friesians predominate, and that it is least in the South-west Peninsula, in the extreme west of which Channel Island breeds predominate.[2]

There are substantial differences between the several regions in seasonal milk yield and these differences, in this instance, are closely related to differences in environment. Yield in summer appears to be higher in northern than in southern districts, and may be in part a function of the tendency of pastures in southern England to dry up in summer. Yield in winter, on the other hand, is highest in the eastern arable districts where food is available on the farm for winter feeding. There is a marked regional variation also in costs of milk

[1] Some would add according to method of milking, being lower in an open-air bail than indoors (*The Mechanization of Milk Production* (1946), p. 28).

[2] The evidence for North Wales is contradictory, status being high in the returns of the Milk Investigation Scheme, but low in the *Agricultural Output*. South Wales has a low status in each case.

production; they are lowest in winter in the eastern arable districts and lowest in summer in the western grass districts, except in the north-west and in North Wales, with their expensive feeding of concentrates. In consequence of the high cost of winter milk production in western districts, winter milk production is here at a low level and the increase in summer striking. In the eastern districts the excess of summer over winter production ranged between 1 and 10 per cent, but in the western districts between 16 and 30 per cent. There is, therefore, in western districts a marked summer surplus, greatest in the south-west corner of Britain where the climate is mild and the grazing season long. This summer surplus goes, of course, into manufacture.[1]

VI

LAND PRODUCTIVITY

It would be a fitting conclusion to these agricultural chapters to classify the regions of the country according to their degree of productivity. A statistical attempt has been made along these lines, taking into account crop statistics for England.[2] Four coefficients were calculated—a productivity coefficient, a ranking coefficient, a price coefficient, and an energy coefficient. The first and second have the disadvantage of using as raw material yields without reference to acreages, but the third and fourth attempt to assess total production on the basis of both yield and acreage. This is more satisfactory, but, even so, the tables give some curious results. The ranking of the counties according to their production of total starch equivalent from a selected list of crops is as follows: Category A—Isle of Ely, Lincoln, Soke of Peterborough, Norfolk, Suffolk, Essex, East Riding, with perhaps Cambridge and Huntingdon; Category B—Bedford, Chester, Cornwall, Hertford, Kent, Lancashire, Nottingham, with perhaps Devon and the North Riding; Category C—Berkshire, Cumberland, Northampton, Oxford, Salop, Rutland, with perhaps Dorset, Buckingham, West Sussex, Durham, and the West Riding; Category D—Hereford, Isle of Wight, Leicester, Middlesex; Somerset, Surrey, Warwick, East Sussex, Westmorland, Worcester, with Hampshire, Northumberland, Stafford, and Wiltshire, intermediate between B and C, and Derby and Gloucester intermediate between C and D. The deficiencies of the method are responsible for some of the curious features of this classification. The investigation does not, in fact, give a satisfactory index either for total productivity[3] from both arable and grass, which it does not pretend

[1] As a result of manipulation of prices winter production has since been increased and the summer surplus diminished.

[2] M. G. Kendall, 'The Geographical Distribution of Crop Productivity in England', *Journal Royal Statistical Society*, vol. CII (1939), pp. 21–62.

[3] An index of total productivity, taking into account production from both arable and grass, is almost impossible to construct on account of the lesser productivity from grass than from arable (approximately one-half); unless, indeed, the

to do, nor for crop productivity alone, for the exclusion of market garden crops results in incomplete information on arable conditions and the inclusion of meadow hay from permanent grass introduces non-arable conditions.[1] The method might give productive results if all arable crops were included and if all non-arable products were excluded, and if calculations of production were made for real agrarian units instead of for the composite counties, each of which (even Rutland) contains several sub-regions within it.

Much more satisfactory are the attempts at classification made by the Land Utilisation Survey and by the Ministry of Agriculture and the Department of Agriculture for Scotland. Both classifications have been printed in colour on the scale of 10 inches to 1 mile,[2] both give an exceedingly valuable picture of the varied agricultural landscape of Britain, and both repay detailed study. Both recognize real agrarian divisions within the counties and both ignore county boundaries. The first, that of the Land Utilisation Survey, recognizes three qualities of land and distinguishes between arable, grass, and heath with their inter-mixtures. The second does not attempt a classification according to quality, but distinguishes types of farming, first, according to the proportion of the total acreage in crops and grass which is under the plough, and, second, according to the dominant enterprise, such as dairying or corn and sheep or cash cropping or market gardening. The first was drawn up on the basis of the field-to-field surveys of the Land Utilisation Survey; the second, so it would appear, on the basis of the parish agricultural statistics and on data collected by agricultural economists. Although they each recognize the same agrarian divisions (with some divergencies), they do not give them identical boundaries. In some parts of the country the one classification is the more detailed, in other parts of the country the other presents the finer detail. The first has been discussed by Prof. L. D. Stamp, the Director of the Land Utilisation Survey, in a report of the survey, *Fertility, Productivity, and Classification of Land in Britain*, and in a paper with the same title to the Royal Geographical Society.[3] The second has been used extensively by the Ministry of Agriculture, and especially in the *National Farm Survey of England and Wales*,[4] which drew up a statistical presentation of farm data for each of the twenty-one

production from grass in the form of stock products (after due allowance had been made for concentrate feeding) be multiplied by two, or some similar number, in order to take account of this lesser productivity from grass.

[1] The ten crops used are the following: wheat, barley, oats, beans, peas, potatoes, turnips and swedes, mangolds, hay (temporary grass), hay (permanent grass).

[2] *Land Classification* (1944) and *Types of Farming* (1944) respectively. Great Britain is covered by two sheets in each case.

[3] L. D. Stamp, 'Fertility, Productivity, and Classification of Land in Britain', *Geographical Journal*, vol. XCVI (1940).

[4] *National Farm Survey of England and Wales*. A Summary Report (1946). The parallel inquiry in Scotland ran along different lines and the Scottish report is an attempt to forecast future levels of productivity.

farming types distinguished.[1] It would be unjust to try to summarize in the small space that is available here these valuable maps and reports, and the reader is recommended to study them in detail. In the same group and of the same value as these is the Grassland Map of England and Wales, constructed by the Grassland Improvement Station and reproduced earlier in this chapter. Attempts have been made to classify land on the evidence of rent on the assumption that the more productive land carries the greater rent. But rent as an index of productivity has many pitfalls: it varies with the size of the holding, being relatively higher per acre with the smaller than with the larger, for it includes house and buildings as well as fields: it varies with the particular use to which the land is put, for some forms of farming enterprise are more profitable than others. Rent, in fact, registers earning capacity rather than productivity.[2]

There is a third approach to the problem. The density of the stocking of grassland, as an index of land productivity, is capable of analysis along the lines of my own work on the Fylde. Other sample treatments in less refined terms, which I or others have made, have been included earlier in this chapter. It may be submitted that such an analysis covering the entire country, intricate and intensive as it must be, would give fruitful results in this problem of land productivity.

[1] These statistical tables have two disadvantages from a geographical point of view. In most groups several farming regions are lumped together to form one farming type. The Fenlands, South-west Lancashire, the Humber warp-land, and some additional small patches elsewhere, constitute one such farming type. These are similar, but they are not identical, and for the purposes of geographical analysis they require separate recognition. This disadvantage, however, is inherent in all systems of grouping. The second disadvantage is that rough grazings are ignored, with misleading results in consequence. The X group, described as land of small agricultural value, is recorded as having no less than 268·3 sheep, 11·5 cows, and 17·7 other cattle per 100 acres. These densities are fictitious, for they are calculated on improved land alone, which in fact constitutes considerably less than half of the total area of the farms placed in this group.

[2] L. D. Stamp, *The Land of Britain, Its Use and Misuse* (1948); *National Farm Survey of England and Wales* (1946); *Landownership in Three Districts in Yorkshire*, University of Leeds Farmers' Report No. 94 (1950).

CHAPTER VI

COAL MINING

I

COAL RESOURCES

THE preliminary to a full geographical analysis of coal-mining is a survey of the structural characteristics, of the bulk of the reserve, and of the quality of the coals of each British coalfield. These condition the cost and the proceeds of mining in each field. There is not space to consider them at the outset, but reference will be made to these qualities as they arise in the course of the regional analysis. In lieu of such a survey two tables have been included, Table XXXI giving chemical analyses of some typical British coals and Table XXXII the reserves for groups of fields. Table XXXII gives reserves according to (*a*) the estimates of the District Commissioners and of the Geological Committee of the Royal Commission on Coal Supplies which reported in 1905, (*b*) the estimates submitted by Dr. Strahan to the International Geological Congress in 1913, and (*c*) the estimates of the 1946 *Rapid Survey of Coal Reserves and*

TABLE XXXI

Analyses of British Coals

		Percentage of dry ashless coal					Percentage of dry coal	Volatiles	Ratios	
		C	H	O	N	S	Ash		C/H	O/H
B1	Bituminous, non-caking	80·3	5·3	12·2	1·4	0·9	7·1	43·5	15·3	2·3
B2	Bituminous gas	83·3	5·1	8·9	2·0	0·7	4·1	38·7	16·3	1·7
B3	Bituminous coking . .	87·8	5·0	5·0	1·6	0·8	3·5	25·5	17·6	1·0
B/C	Semi-bituminous steam . .	90·7	4·7	3·2	1·5	—	4·8	19·8	19·3	0·7
C2	Anthracite .	93·9	3·4	1·5	1·2	—	2·1	5·7	27·6	0·4

C=Carbon; H=Hydrogen; O=Oxygen; N=Nitrogen; S=Sulphur.

The above analyses are from the following seams: B1, Deep Hard, Nottingham; B2, Yard, Northumberland; B3, Busty, Durham; B/C, Red Vein, South Wales; C2, Stanllyd, South Wales. C2 from Walcot Gibson, *Coal in Great Britain* (1927), p. 138; the rest from W. A. Bone and G. W. Himus, *Coal: Its Constitution and Uses* (1936), pp. 82–3 and 85.

Production. The quantity of coal mined since 1905 has been added to the table. The net quantities, those recorded in 1905, were arrived at from the gross quantities, those reported to the International Geological Congress, by the subtraction of the amount of coal which must be left in the mine to provide pillars to prevent subsidence and by the subtraction of the amount of coal absent or crushed in proximity to 'wash-outs' and faults. These subtractions are substantial, amounting to 20·7 per cent in South Wales and to considerably more than this in the Yorkshire–Derby–Nottingham field.[1] Taking into account the unproved as well as the proved, the largest field is clearly the Yorkshire–Derby–Nottingham and the next largest is the South Wales. The Scottish and the North-east Coast fields are in the second category in order of magnitude. The Lancashire, the North Staffordshire, and the South Staffordshire, Warwickshire, and Leicestershire fields, as a group, are in the third category.

TABLE XXXII

Coal Reserves of British Coalfields

	1905 Estimate (million long tons)		1913 Estimate (million metric tons)		1946 Estimate (million tons)	Quantity mined (million tons) 1905–49
	Proved	Unproved	Actual	Probable and Possible	Developed Reserves	
Scotland	10,372	—	21,377	—	2,373	1,393
North-east Coast	10,781	—	11,023	2,518	3,710	1,929
Yorks, Derby, Notts	26,499	23,000	40,254	14,854	6,797	3,120*
Lancashire–Cheshire	4,530	2,987	5,636	3,085	997	869
North Wales	1,736		2,536		214	
North Staffs.	4,368	1,742	11,561	21,547	670	808†
Salop, South Staffs, Leics, Warwick	4,689	10,956			1,736	
South Wales	28,336	—	36,010	208	3,289	1,728
Others	6,872	800	6,715	4,027	714	247
	98,183	39,485	135,112	46,239	20,500	10,094

* Inclusive of South Derby and Leicester.
† Exclusive of South Derby and Leicester.

From *Final Report*, Royal Commission on Coal Supplies (1905), and from *The Coal Resources of the World*, International Geological Congress (1913).

In the 1905 estimates the 'proved' reserves are those of the District Commissioners, the 'unproved' those of the Geological Committee; in each case they are net figures. The 1913 estimates are gross figures. Both 1905 and 1913 estimates refer to seams over 1 foot thick and lying within 4,000 feet of the surface.

The 1946 estimates are those of the *Rapid Survey of Coal Reserves and Production* (1946), Fuel Research Survey Paper no. 58. They refer 'only to the coal likely to be raised during the next 100 years' (p. 2).

[1] *Final Report* (Royal Commission on Coal Supplies (1905), pt. II, p. 5, and pt. V, pp. 1–2). Improvements in mining methods and in filling underground cavities after removal of coal would increase the net figure.

II

THE ECONOMY OF THE INDUSTRY

All the coalfields of Britain are being worked, but with varying intensity, the degree of intensity depending on three sets of factors: (*a*) the physical constitution of the field, (*b*) the geographical position of the field in relation to centres of coal consumption at home and abroad, and (*c*) the efficiency with which the field is worked. The location of coal-mining is fixed by the existence of underground resources of coal, but the volume of output and the relative importance of one field with another is to some extent affected by human management and by the whole pattern of the economic geography.

Let us look, first, at the position in Great Britain as a whole and, second, at the regional variations on this general theme presented by individual coalfields.

Since the peak of 1913, coal output in Great Britain as a whole has declined. There were violent fluctuations downwards in 1921 and 1926 owing to the British strikes of those years, and upwards in 1923–4 owing to the French occupation of the Ruhr, and it was not until 1927–8 that the effects of these temporary dislocations were eliminated. For the 'normal' years of the decade 1919–28 Prof. J. H. Jones estimated the output at approximately 250 million tons,[1] as compared with the returned output of 287·3 million tons in 1913. During the world trade depression output of coal in Great Britain fell steadily from 257·9 million tons in 1929 to 207·1 million tons in 1933, but it subsequently recovered gradually to 240·4 million tons in 1937. It fell again in each succeeding year to 183 million tons in 1945, but has since risen slowly to 190 in 1946, 197 in 1947, 209 in 1948, 215 in 1949, and 216 in 1950.[2]

The causes of this contraction in output are not obscure. Although parts of individual coalfields and individual seams in others are in an economic sense worked out,[3] the coal resources of the country as a whole are not by any means approaching exhaustion. At an output level of 250 million tons the *proved* reserves would last for approximately another 350 years.[4] Whether output ought to be limited in order to conserve national coal resources is an arguable point.[5] The

[1] J. H. Jones, 'The Present Position of the British Coal Trade', *Journal Royal Statistical Society*, vol. XCIII (1930), p. 13.

[2] Inclusive of open-cast coal in 1949–50.

[3] This is in an economic and not in a physical sense, for some coal is left underground to support the roof, to mark boundaries between properties and in seams too thin to work profitably. The boundary coal has become available under nationalization.

[4] This estimate is based on the net reserve of the 1905 Commission after the output for 1905–49 has been deducted.

[5] The Royal Commission on the Coal Industry (1925) took the view that 'it is unnecessary to contemplate any restrictions upon the production of coal' (*Report*,

decline in output, as all agree, was during the inter-war period due to a decline in the demand for British coal, and at the present time is due to the difficulty of recruiting pit labour. The reasons for the decline in demand were several. In the first place, the demand for coal fluctuates with the trade-cycle, demand being active at the peak and restricted in the trough of the cycle. British coal output was high in 1929 and in 1937 at crests of the trade-cycle, and low in 1931–3 at the trough. Fluctuations of this kind apply to all kinds of consumers of coal to a greater or a lesser degree. In the second place, the demand for British coal fell with the decline in the volume of particular coal-using industries between the wars; as, for example, Lancashire cotton manufacture or British iron smelting, both long-term declines independent of the trade-cycle. In the third place, the demand for coal has declined owing to the substitution of other means of producing power—fuel oil, petrol, and hydro-electricity. The effect of fuel oil and petrol is most marked in respect of locomotive vehicles by sea and land and of hydro-electric power in respect of fixed industrial plants and public services providing light and heat. In the fourth place, the demand for British coal abroad has declined and the markets formerly supplied from Britain have been supplied by coal produced in other countries.[1] In some cases this is due to the greater geographical proximity of alternative sources of supply recently developed, as, for example, Turkish coal in the southern Black Sea and Indian and Natal coal in India.

Table XXXIII enables an estimate to be made of the extent of these changes among different types of consumers. It gives particulars of the consumption of British coal for 1913, 1929, 1932, 1937, and 1949. These years are not random choices; 1913, 1929, and 1937 were years of maximum coal output and of maximum industrial activity at the crest of a trade-cycle, while 1932 was a year of minimum coal output in the trough of a trade-cycle, and 1949 the most recent year for which returns were available at the time of writing in the form required. In 1937 the level of home consumption was very similar to that in 1913, but the export abroad had declined catastrophically: as a percentage of the 1913 level, home consumption was 99 in 1937, but shipment abroad only 57.[2] It will be noticed that home consumption in 1949 was of the same order of magnitude

p. 20). Recently, quite the reverse view has been expressed. See Chapter I of *The Efficient Use of Fuel* (1944). The Reid Committee expresses the view that the 'resources, which at best are limited, must be . . . intelligently conserved' (p. 118) *Coal Mining Report of the Technical Advisory Committee*, Cmd. 6610 (1945.)

[1] World production of coal and lignite together (with lignite in coal equivalents, 1 ton of lignite being equivalent to five-fourteenths of a ton of coal) was 1,262 million tons (metric) in 1913 and 1,185 million tons (metric) in 1935, a decline of 6 per cent. But in Great Britain during the same period decline in output amounted to 22 per cent and decline in export cargoes to 56 per cent.

[2] If shipments to the Irish Free State be excluded in 1937 as they were excluded in 1913, then the figure becomes 55.

as in the inter-war period, but that exports had fallen further owing to restricted supplies. The *long-term* contraction of coal output in Great Britain is thus chiefly the result of decreased shipments abroad, whether to countries abroad or as bunkers in vessels engaged in foreign trade. Decline in home demand for coal by declining industries appears therefore to have been balanced at the crest of a trade-cycle by an increase in demand from expanding industries and public services. The level of home consumption, however, has varied substantially between the crests and troughs of the trade-cycles, the maximum amount of variation probably being of the order of 24 to 32 million tons, representing an average amplitude of something over 15 per cent. The decreased shipments abroad represent a long-term decline only slightly affected by the short-term fluctuations of the trade-cycle. Such decline in exports has been due to falls in the level of export prices, and since 1939, to control and the circumstances of the war and its aftermath. Intense competition from coalfields abroad,[1] particularly from those of the Ruhr and Upper Silesia, was responsible for the fall in export price-levels. The labour costs of production per ton of coal during the inter-war period were considerably lower in Polish Upper Silesia and somewhat lower in the Ruhr than in British exporting districts, output per man-shift being substantially higher in each field than in Great Britain and wage-rates in Poland being substantially lower in addition.[2] But both Upper Silesia and the Ruhr are situated far inland, and this distinct disadvantage was offset during the inter-war period by manipulation of railway rates and by manipulation of coal prices whereby both in Poland and in Germany prices in contested markets, such as export markets, have been lower than in non-contested markets.[3] The competition of these continental fields had to some extent been stabilized by agreements with Poland and the Scandinavian countries. Fall in the volume of export has had profound geographical repercussions within Britain, for some British fields owing to their geographical position have specialized on the export market, and these, which had an expanding output prior to 1914, have had a contracting output during the last two decades.

[1] A. M. Neuman, *Economic Organization of the British Coal Industry* (1934), p. 39. The average length of haul for coal from pit to port for export was stated in 1925 to be 20 miles for the Scottish and South Wales fields and 10½ miles for the North-east Coast, a weighted average for the export trade as a whole of approximately 16–17 miles (Royal Commission on the Coal Industry (1925), *Minutes of Evidence*, vol. IIB, p. 807).

[2] *The World Coal-mining Industry*, vol. I (1938), pp. 174–7, International Labour Office. These differences are likely to remain, even to be intensified in the forseeable future.

[3] In 1928 a direct subsidy on exports was tried out by the Central Collieries Commercial Association, and it increased the shipment of coal from Humber ports. For the case against such a practice, see *The Second Industrial Survey of South Wales*, vol. I (1937), pp. 48–50. For the need for common international action, see J. R. Bellerby, *Coal-mining: A European Remedy* (1928).

TABLE XXXIII

Consumption of Coal Output

	Actual quantities in million tons					Percentages				
	1913	1929	1932	1937	1949	1913	1929	1932	1937	1949
Output	287·3	257·9	208·7	240·4	214·8	100·0	100·0	100·0	100·0	100·0
Shipment abroad	94·4	76·7	53·1	52·0	21·1	32·9	29·8	25·4	21·6	9·8
Available for home consumption	192·9	181·2	155·6	188·4	193·7	67·1	70·2	74·8	78·4	90·2
Home consumption:										
Gas works	16·7	16·8	16·4	18·2	25·4	9·1	9·7	10·9	10·0	13·1
Electricity plants	4·9	9·8	9·8	14·7	30·1	2·7	5·7	6·6	8·1	15·6
Railway locomotives	13·2	13·4	11·7	13·1	14·8	7·2	7·7	7·8	7·2	7·7
Colliery engines	18·0	13·7	12·0	12·2	10·8	9·8	7·9	8·1	6·7	5·6
Coastwise bunkers	1·9	1·4	1·2	1·2	0·9	1·0	0·8	0·8	0·7	0·5
Blast furnaces	21·2	14·5	6·5	14·7	15·0	11·5	8·4	4·4	8·1	7·7
Industrial and domestic	107·9	103·9	91·9	107·7	96·2	58·7	59·8	61·4	59·2	49·8
	183·8	173·5	149·5	181·8	193·2	100·0	100·0	100·0	100·0	100·0
Export:										
Baltic and Scandinavia	15·9	6·7	5·3	10·2	3·5	21·7	11·1	13·5	25·3	25·1
North Sea	13·0	12·8	5·7	5·3	1·6	17·7	21·2	14·6	13·1	11·6
France	12·8	13·0	8·9	8·9	1·5	17·4	21·6	22·9	22·0	10·7
Mediterranean	21·6	16·2	10·8	7·4	2·8	29·4	26·9	27·7	18·4	19·9
West Africa	1·6	1·0	0·5	0·5	0·6	2·2	1·7	1·2	1·3	4·3
North and Central America	0·2	1·2	2·4	1·4	0·3	0·2	1·9	6·1	3·5	2·2
South America	7·0	5·3	3·0	3·1	1·1	9·5	8·8	7·6	7·8	8·2
Others (including Eire)	1·3	4·1	2·5	3·4	2·5	1·9	6·8	6·4	8·6	18·0
	73·4	60·3	38·9	40·3	13·9	100·0	100·0	100·0	100·0	100·0
Bunkers for foreign trade	21·0	16·4	14·2	11·7	5·0	—	—	—	—	—

Shipment abroad comprises export of (1) coal for consumption in importing countries, (2) coal for bunkering vessels in foreign trade, (3) coal equivalent of exported coke and manufactured fuel. The quantity available for home consumption is a residual figure after deduction of shipments abroad.

Let us now split up home consumption and export abroad each into its several parts and examine the extent of change in more detail. Although home consumption as a whole has remained steady, there have been substantial changes within this total. Domestic consumption of raw coal has declined to a certain extent owing to the greater efficiency of the domestic grate and to the increase in gas and electric fires and stoves, despite the continued increase in the number of houses. With coal rationing, domestic consumption has declined from 45·8 million tons in 1938 to 30·9 in 1949, but consumption by gas and electricity undertakings increased from 34·4 to 55·5 million tons. Consumption of coal direct by industry as a whole has decreased very little, though there have been striking long-term decreases and increases in particular industries and substantial fluctuations within a trade-cycle in most industries.[1] The consumption of coal by blast furnaces, for example, was in 1932 under half that in 1929 and 1937, but in 1929 and 1937 it was two-thirds of what it had been in 1913: it has now been stabilized at a level slightly above that of 1937. The quantities of locomotive coal used vary with the activity of the railways, being higher at the crest than in the trough of a trade-cycle, though there appears also to have been some slight increase in the efficiency of the locomotive engine.

The decline in coal shipment abroad has affected most export markets, except the Canadian, whose import of coal from Great Britain (chiefly South Wales anthracite for stove-heating) greatly increased during the inter-war period, though it had perforce to be restricted during the late war. The returns since 1923 are complicated by the inclusion of exports to the Irish Free State of the magnitude of 2½ million tons annually in recent years, trade which was reckoned as coastwise before that date.[2] The chief fields of export are, and always have been, the coasts of the European peninsula from the Baltic to the East Mediterranean. The steadiest of these markets has been France, but even here exports in 1937 were barely 70 per cent of their 1913 level. Exports to Scandinavia almost doubled between 1932 and 1937 as a result of agreements whereby the Scandinavian countries undertook to take an agreed proportion of their coal imports from Britain.[3] Even these increases, however, were insufficient to restore the 1913 level. Elsewhere in Europe

[1] Details of change in coal consumption by particular industries are available in the Censuses of Production for 1924, 1930, and 1935, dates which are not particularly convenient for the purpose as they each occupy indeterminate positions relative to the trade cycles. It would appear, however, that consumption of coal *direct* had fallen substantially in the textile, clothing, iron and steel, engineering, shipbuilding, and non-ferrous metal industries, but that it had increased in the food, chemical, and paper industries. For 1924 and 1930, see Part V of the *Final Report* of the 1930 Census of Production (1935).

[2] After a fall during the war it recovered to 1½ million tons by 1948.

[3] Denmark, 80 per cent; Norway, 70 per cent; Sweden, 47 per cent. Exports to the Netherlands and to Belgium have in particular years reached levels higher than those of 1913, but exports to these countries fluctuate widely.

imports of British coal have declined catastrophically. It would be misleading to analyse the *distribution* of exports at the time of writing, for this is due to temporary circumstances.

After this discussion of the decline in output, its extent and its causes, let us now consider the general economic position of the British coal industry as a preliminary to a discussion of its regional variations. The general economic position during the inter-war period may be described simply as one with an output capacity greater than actual production and, it was possible to add until 1942, a skilled personnel in excess of available employment. The problem at the present day is not markets but labour. There is a reluctance to enter the pits so long as other employment is available. Improvement in wages and working conditions in the pits in order to attract labour are measures appropriate to a self-sufficient economy, but impose a severe burden on a competitive export economy.

Let us look at the conditions of the inter-war period. Some excess of capacity over production is unavoidable on account of the seasonal character of output: it is necessary that the industry should be able to produce at the level of peak demand. Over the six years, 1933–8, the average seasonal variation between the third quarter, the lowest in output, and the first and fourth quarters, the highest in output, was 12·8 per cent for Great Britain as a whole.[1] For 1927 it was estimated that productive capacity was some 20 per cent in excess of actual production at a time when annual output was 251 million tons.[2] There was some reduction in excess capacity after that date, and it was estimated in 1937 that productive capacity had fallen from 300 to 255 million tons, representing an excess of capacity over output in 1937 of little more than 6 per cent.[3] It would appear that capacity had become more closely adjusted to output.[4] The gap between output and capacity brought intense competition for the reduced demand. The exporting coalfields, which suffered most from the decline in demand, tried wherever possible to invade the markets supplied by the inland fields; in this the North-east Coast field had more success than the Scottish or South Wales fields. Unregulated competition did not prove to be wholly effective in reducing capacity, and it was having grave social results in causing certain districts to become derelict and in inducing attempts to reduce miners' earnings in order to cut down production costs. The Coal Mines Act of 1930 terminated this phase of unregulated competition. Although it did not result in expansion of output, the Act gave

[1] In those districts producing large quantities of house coal, the magnitude of the seasonal variation is greater and is of the order of 25 per cent.

[2] J. H. Jones, G. Cartwright, and P. H. Guénault, *The Coal-mining Industry* (1939), p. 88. A League of Nations Economic Committee Report in 1929 estimated excess capacity at between one-quarter and one-third.

[3] W. A. Lee, *Sales Organization in the Coal Industry*.

[4] That is, at the crest of the trade cycle in 1937.

stability of prices, a freedom from disputes, and an opportunity to reorganize production.[1] The objects of the 1930 Act were, firstly (Part 1), to regulate output to accord with demand by allocating quarterly a tonnage for each district and a quota for each colliery within the district, and, secondly (Part 2), to promote the increased efficiency of production by amalgamation. The regulation of output by fixing quotas tended to stabilize the geographical distribution of the industry, the new efficient pits having tended to suffer and the old less efficient pits to gain as compared with what would probably have happened if regulation had been absent. It was, however, possible to transfer quotas by purchase,[2] and some redistribution of production resulted in consequence. Redistribution of production was easier in the case of large concerns having several pits in the same field, for, according to the 1930 Act, a quota may be determined for two or more mines in the same undertaking in the same district as if they were one mine.[3] This made it possible for a firm owning several pits in the same coalfield to concentrate the whole of its quota on its more efficient pits. This happened extensively in Lancashire. To the extent that less efficient pits have been kept in production the quota system hindered improvement in the efficiency of the industry, but it eased the transition socially in those districts in process of becoming derelict. The control of output has thus (in so far as it affects distribution of output) a geographical aspect as well as an economic. Improvement in efficiency by amalgamation, the object of Part 2 of the Act, met with setbacks, but improvement in efficiency by increased mechanization of production went on independently of the Act. It is yet too early to see what the effects of nationalization will be, whether on the economic position of the industry as a whole or on the policy to be adopted towards the distribution of pits within a coalfield. The Coal Industry Nationalization Act (1946) was concerned with transfer of ownership and not directly with the problems which are the concern of this book. These are the concern of the National Coal Board set up by the Act.

A suitable index of efficiency of production, and of changes in that efficiency, is provided by output per person employed. Different fields have different efficiencies, and this affects the scale of their

[1] Jones, Cartwright, and Guénault, op. cit., pp. 147–66. Also Lee, op. cit. In view of the onset of the world depression in 1930 and the general fall of prices accompanying it, the price stability in the coal industry in spite of a decline in demand was exceptional. Coal export prices on the European continent, however, did fall, and continued to fall after 1932, when production was increasing. It would seem, therefore, that the competitive position of British coal export worsened: British coal exports certainly failed to increase after 1932. In regulating competition within the country and in maintaining prices and wages, Britain insulated herself from the rest of the world and took one more step towards a self-sufficient economy.

[2] The purchase of quotas was abolished in South Wales and unused quotas were pooled (*The Second Industrial Survey of South Wales*), vol. 1 (1937), p. 57).

[3] Pt. 1, Section 3 (2).

production. Coal-mining is still in part a handicraft industry, and output per man is therefore more satisfactory than output per machine. Output per person employed underground is the result of the physical character of the mine, of the age of the mine, of the degree of mechanized working, and of the hours worked.[1] It thus embodies the effects alike of the physical environment and of human management and serves as a useful index of geographical variation. The physical characteristics which favour high output per person employed underground are thick seams devoid of dirt partings, with a solid roof and floor, and lying horizontal or only slightly inclined. A newly opened mine means working faces near to the shaft bottom, unless a retreating longwall system of working is practised,[2] and a limitation of the useless time spent underground walking or being conveyed from the shaft bottom to the working face. An old mine has usually worked, and perhaps exhausted, its most easily won seams, and for this reason, as well as because of distance of coal face from shaft bottom, output per person is usually lower than in new mines, other things being equal. Mechanization increases output per head, despite the increase in personnel in the form of mechanics to maintain the machines. Machines, however, require capital resources and, if the seam can be worked without machines, the tendency has hitherto been to delay their introduction. Hence it came about that mechanical coal-getters were most numerous in

[1] Some would add also size of mine. The *Report* of the 1925 Royal Commission quoted returns to the effect that output per man-shift increased with size of mine. These returns were set out in two ways: (*a*) according to size of *mine* on the basis of number employed, and (*b*) according to size of *undertaking* on the basis of output. On the first basis the increase was from 16·6 cwt. in mines employing under fifty to 18·2 cwt. in mines employing over 1,000, both above and below ground; on the second basis increase was from 12·8 cwt. in undertakings with an output of less than 5,000 tons per annum to 19·8 cwt. in undertakings with an output of over 2 million tons per annum. Mines and undertakings are not synonymous for an undertaking may include several mines. The returns quoted in the *Report*, however, as Dron (R. W. Dron, *The Economics of Coal Mining* (1928), pp. 111–18) has pointed out, refer to Great Britain as a whole, and in this instance the returns for the Yorkshire–Derby–Nottingham field, where output does increase with size of mine, mask all other returns. Of the concealed field of South Yorkshire and Nottingham, it is unquestionably true that large mines are more efficient than small in the sense of larger output per man-shift, but it is also true that in other coalfields more extensively broken by faulting the large mine is not necessarily more efficient than the small. In Scotland and in Lancashire, both badly faulted, output per man-shift in the larger mines is less than in the smaller. The question of optimum size thus varies with the coalfield; it is, in other words, subject to geographical variation and depends in large measure on the structural character of the field. This regional difference between the Yorkshire–Derby–Nottingham field and all other fields refers to output per man-shift of *all employed*, both above and below ground. In output per man-shift of those working at the coal face alone there is an increase with increasing size of mine in every field, including Scotland and Lancashire.

[2] Of the total output in 1948, 83 per cent was obtained by longwall advancing, 3 per cent by longwall retreating, 13 per cent by room and pillar (*Statistical Digest*, Ministry of Fuel and Power (1950)). For an account of these methods, see the Reid Report (*Coal Mining: Report of the Technical Advisory Committee* (1945), Cmd. 6610, pp. 39–51).

working the thinner seams. Some thick seams, moreover,[1] have proved difficult to work by machine on account of the risk of coal falling on the machine while at work. The effect of hours worked is obvious, but it does not necessarily follow that an increase in hours would produce a proportionate increase in output, for with the longer working day output per hour may fall. It has been asserted by those with practical colliery experience that a coal hewer works harder per hour if working only a few shifts per week than if working a full week.[2]

What are the changes that have taken place in output per head in the country as a whole? The annual output per head employed underground declined in the latter part of the nineteenth century; this was despite an increase in total output which, as under these conditions labour is fully employed,[3] usually results in a high output per head. In the later years of both the 1914–18 and 1939–45 wars, with dilution of labour owing to war conditions, output per head fell rapidly. After the low level of 1919–20 output per head began to rise, quickly in periods of increasing total output, but less quickly or not at all in years of decreasing total output. In 1937 it surpassed the level of 1900. It is now recovering from the level of 1945. This test, however, is not a wholly satisfactory index of efficiency. More satisfactory is output per man-shift; it is more satisfactory because it eliminates differences between one year and another owing to short-time working. Returns of output per man-shift are available continuously only from the second half of 1918, and prior to that date there is only one return, for the single month of June 1914. The curve showing output per man-shift exhibits in general terms a similar trend to the curve showing annual output per person employed underground, but the amplitude of variation is less, as might be expected. In June 1914 output per man-shift was 20·32 cwt., by 1920 it had fallen to 14·57 cwt., but it subsequently rose to 23·54 cwt. in 1936. It was 20·0 cwt. in 1944–5 and 23·2 cwt. in 1949. It is clear, therefore, that there were two movements—first, a decline, and, later, an increase in efficiency. The decline in efficiency was a reflection of the increasing physical difficulties due to the age of British coal-mines which have been compelled to sink deep shafts and to work thin seams.[4] The chief reason for the increasing efficiency since 1920

[1] In 1924 79 per cent of the total output from seams under 1 foot thick was got by machine, but less than 10 per cent of the total output from seams over 5 feet thick. These refer to Great Britain as a whole (Royal Commission on the Coal Industry (1925), *Report*, vol. III, p. 184). In 1944 the percentage cut by machine was 85 per cent for seams under 2 feet thick, 54 per cent for seams 6 feet thick and over. The range of variation is decreasing (*Statistical Digest, 1945*, Ministry of Fuel and Power (1946), Cmd. 6920).

[2] Discussion on paper by E. C. Rhodes, 'Labour and Output in Coal-mining', *Journal Royal Statistical Society*, vol. XCIV (1931), pp. 530 and 533.

[3] For an explanation, see Rhodes, op. cit., p. 513.

[4] For Great Britain as a whole the proportion of the total output contributed by seams under 4 feet in thickness (see footnote to Table XXXIV for explanation

is the increasing degree of mechanization. Underground mechanization takes the form of cutting by machine at the coal face and of conveying the coal thus cut by mechanical conveyor. The percentage of the output cut by machine was 8 in 1913, 59 in 1938, and 76 in 1948, and the percentage handled mechanically was 54 in 1938 and 78 in 1948. Obsolescence, tending to depress output, and mechanization, tending to increase output, thus act against each other, and changes in output per man-shift (other things being equal) are the result of their relative strength. It has frequently been emphasized that mechanization is the most satisfactory method within human control by which output per man-shift can be increased. Increase of hours of work may assist, though not necessarily, for there may be a lesser output per hour with a longer shift.

III

REGIONAL ANALYSIS OF COAL-MINING

This is the general economic pattern of the coal industry as a whole. Conditions vary very much from field to field in physical constitution, in degree of obsolescence, in position relative to the detailed distribution pattern of industry, population, and trade, and in mechanization. Against this general background, it is now possible to analyse the production of coal in each field in turn.

The Scottish coalfields are characterized physically by relatively thin seams,[1] by a quality of coal rather below the average,[2] and by much faulting, but, as the fields are wholly exposed, by seams relatively near the surface and easily accessible. The relatively thin seams are perhaps a reflection of the early age of Scottish coals, for they belong to the Lower Carboniferous and to the Lower Coal Measures. Mining is chiefly from pits of shallow or medium depths, and, because of shallow mining and faulting, pits are relatively small.[3] There is no evidence in Scotland of output per man-shift increasing with size of mine,[4] the field being badly faulted and the small mines having the advantage that time is reduced in order to get from shaft bottom to working place. The disadvantages due to thin seams have been met by efficient management in the form of a high degree of mechanization, particularly of coal-cutters. For many

of these returns) was 45·4 per cent in 1913, but 49·1 per cent in 1924 and 55·0 per cent in 1944, and the proportion of the total output from seams more than 1,800 feet below the surface 9·4 per cent in 1913, but 13·6 per cent in 1924, and 17·2 per cent in 1944.

[1] For the nature of the data on seam thicknesses, see footnote to Table XXXIV.

[2] *An Industrial Survey of the South-west of Scotland* (1932), p. 43. This statement does not apply to Fife steam coals and Lanark coking coals.

[3] The size-group employing the greatest number of men underground is the 1–499. This is true of all Scottish fields except Fife and Midlothian, where the most important is that employing 500–999 underground. This was in 1938.

[4] Royal Commission on the Coal Industry (1925), *Report*, vol. III, p. 196.

TABLE XXXIV

Physical and Economic Characteristics of Individual Coalfields

	Great Britain	Scotland	Northumberland	Durham	South Wales	South Yorks	West Yorks	Notts and Derby	Leics., Warwick, Cannock	Lancs, North Staffs.
Thickness of seam										
Percentage of tonnage from thicknesses filled out of over 4 ft. 1913	54·6	35·5	25·5	46·7	66·6	79·7	37·3	60·0	85·2	47·7
1924	50·9	25 3	23·1	40·5	60·2	76·5	30·6	58·1	81·2	52·3
1944	46·0	38·2	19·4	34·9	51·6	56·2	21·8	42·6	76·6	45·8
Depth of seam from surface										
Percentage of tonnage from seams deeper than 600 yards. 1913 .	9·4	2·4	—	0·4	11·1	34·3	12·4	1·7	2·1	19·2
1924 .	13·6	2·6	—	0·6	13·1	40·4	14·3	9·8	5·4	29·2
Average distance in miles from shaft bottom to working place . .	0·9	0·6	1·0	1·1	0·9	1·1	1·1	1·1	0·9	0·7
Mechanization										
Percentage cut by machine. 1913 .	8	22	14	4	1	16	17	11	4	8
1938 .	59	80	91	42	26	56	55	78	70	76
1944	71	85	96	43	31	75	68	92	87	91
1948 .	76	85	64		c. 43	79		c. 95	c. 89	c. 92
Size of mine										
Average no. employed underground per mine. 1938	556	342	603	509	504	1152	597	650	635	548
Percentage of total employed underground in 1938 in mines employing										
1– 499	27·5	57·4	28·8	21·8	29·6	5·6	22·6	28·2	18·9	29·7
500– 999	32·7	30·4	42·4	39·6	36·3	13·9	25·5	29·9	44·0	40·8
1,000–1,499	21·4	6·8	21·1	15·4	23·7	25·2	19·6	33·6	31·8	20·2
1,500–1,999	9·2	2·3	—	12·1	8·6	19·8	19·6	5·1	5·3	5·2
2,000 and over	9·2	3·1	7·7	11·1	1·8	35·5	12·7	3·2	—	4·1

Output in million tons 'raised and weighed'										
1913	287·3	42·5	14·8	41·5	56·8	27·7	16·0	30·5	14·0	31·2
1929	257·9	34·2	14·5	39·0	48·1	33·5	12·9	29·8	12·9	21·6
1937	240·4	32·2	14·3	33·5	37·8	32·4	12·7	31·1	13·8	22·3
1949 (deep mined only)	202·7	23·8	11·6	26·2	22·5	41·8		32·3	18·0	18·6
1929 as percentage of 1913	89·8	80·5	98·2	93·9	84·7	121·0	80·6	97·8	92·0	69·0
1937 as percentage of 1913	83·7	75·9	96·1	80·6	66·5	117·1	79·4	101·7	98·6	71·4
1949 as percentage of 1913	70·5	55·1	78·7	63·1	39·7	95·6		106·1	128·3	59·7
Output per man-shift										
In cwt. 1924–5	17·7	19·3	17·8	17·6	15·9	21·0	18·0	21·1	18·2	14·4
1938	23·0	23·3	22·9	21·5	20·1	25·6		28·8	23·8	20·5
1945	20·0	20·0	19·0	16·8	15·0	22·8	19·8	27·9	24·2	19·0
1949	23·2	22·4	19·8		*c.* 17·6	25·4		*c.* 33·2	*c.* 25·6	*c.* 20·6
Cost of production, 1938										
Net total cost per ton	16/–	15/2	14/10	15/5	18/3	15/6		14/5	15/9	18/1
Wages cost per ton	10/7	10/2	9/–	9/7	11/8	10/7		9/11	10/10	11/10
Proceeds per ton	17/4	17/–	16/3	16/4	18/8	16/9		16/2	18/–	19/11
Cost of production, 1949										
Total cost per ton	45/–	45/6	47/7	51/–	54/11	42/4		36/6	39/3	46/8
Wages cost per ton	28/10	28/3	32/10	35/10	34/7	26/8		22/10	24/10	27/4
Proceeds per ton	47/11	47/7	46/3	49/4	54/11	47/3		44/7	44/1	50/–
Balance + or —	+2/11	+2/1	—1/4	—1/8	—	+4/11		+8/1	+4/10	+3/4

Thickness of coal filled out represents thickness of seam (less coal left unworked in floor or roof), together with thickness of dirt partings and of floor or roof worked in winning the coal.

Returns of thickness of coal filled out, of depth of seams from surface, and of distance from working place from Royal Commission on the Coal Industry (1925), *Report*, vol. III. Returns of mechanization from the Annual Reports of H.M. Inspectors of Mines, from the *Statistical Digest* of the Ministry of Fuel and Power and from the *Reports* of the National Coal Board. Size of mine calculated from the *List of Mines, 1938*. Average number employed underground per mine refers only to those employing 50 + underground.

The returns of output and of cost of production are from the Mines Department, the Ministry of Fuel and Power and the National Coal Board. The returns of output per man-shift for 1924–5 have been abstracted from the Royal Commission on the Coal Industry (1925), *Report*, vol. III, p. 196.

years the Scottish coalfields greatly exceeded all others in degree of mechanization. The percentage of coal cut by machine is greatest within Scotland in Fife. As a result of this intense mechanization and despite thin seams and faulting, the output per man-shift was higher than the national average until 1943, and is still surpassed among the large fields only by the Yorkshire–Derby–Nottingham field.[1] Costs of production remained until recent years less than the average in Great Britain until 1949.

Nevertheless, despite this still not unfavourable position, the coal output of Scotland is declining at a faster rate than that of the country as a whole.[2] The reasons for this decline during the inter-war period were largely economic; firstly, industrial depression, particularly in metal-working industries, within the Central Lowlands of Scotland; and, secondly, a decreased demand for coal abroad. The decreased export abroad has been felt by Scottish fields equally with those of the North-east Coast and of South Wales. Some compensation has been obtained, in common with other exporting coalfields, by increased coastwise shipments, but on account of distance from English centres of population rail transport into England has proved impossible. Scottish coal was imported extensively by the Mersey at one period during the last two decades, shipment being favoured by lower costs of coal production in Scotland than in Lancashire. The decline in output, however, is focused in the Central or Lanark field, which has been the most intensively worked in the past, and part of which may be said to be exhausted: in Lanarkshire output in 1938 was exactly half the level of 1913. Exhaustion thus, in part, accounts for the declining output of the Lanark field. It is significant that Lanarkshire has a lower output per man-shift than the other Scottish fields, which have in fact an output well above the average for Great Britain. Much of the output of this field is now from the Limestone Coal Group of the Lower Carboniferous. In Fife the greater part of the output is from the Lower Carboniferous. In 1915 the Ayrshire field produced 12 per cent of the total Scottish output, the Central field 58 per cent, and the Fife and Midlothian fields (with Clackmannan) together 30 per cent; in 1938 the proportions were 15, 45, and 40 per cent respectively, and in 1949, 19, 34, and 47 per cent respectively. The Central Coalfield, which activated the

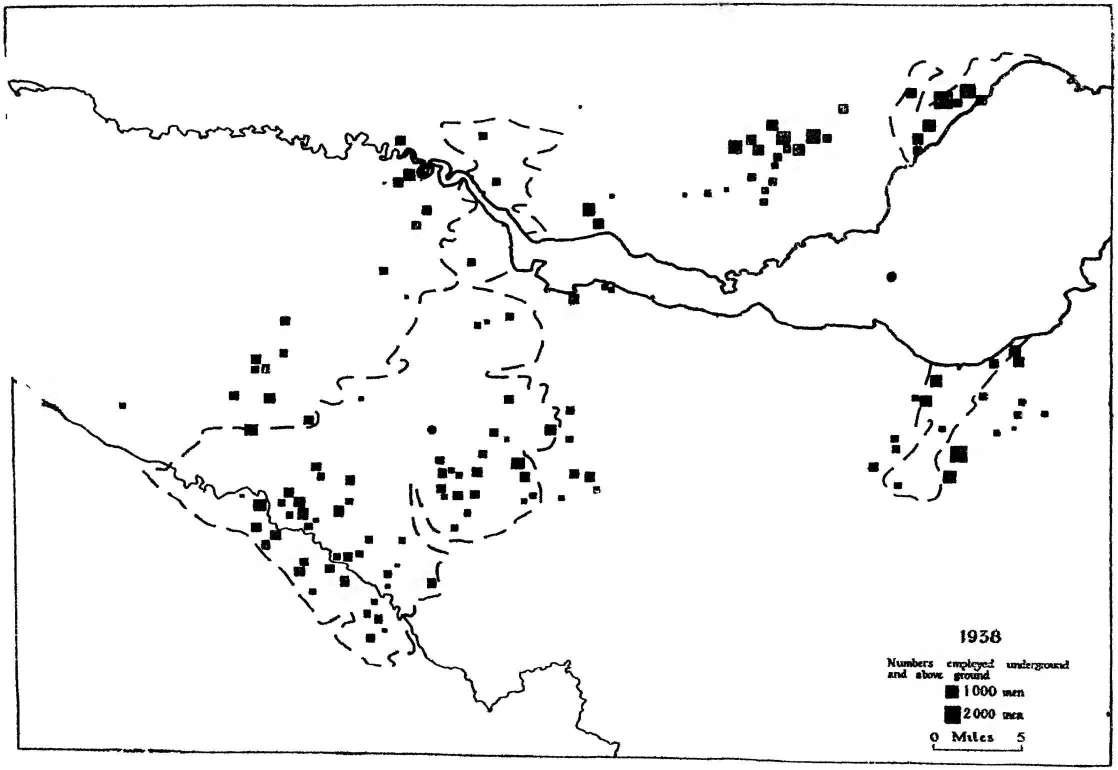
[1] From 1922 to 1926 output in Scotland was 1½ cwt. greater than the national average, and from 1929 to 1935 2¼ cwt. greater, but in 1938 and 1939 the excess output per man-shift in Scotland was only ⅕ cwt., and by 1943 the two were identical. It would appear that the initial lead of Scotland due to more intense mechanization is beginning to disappear. For all fields in Great Britain a given percentage increase in mechanization produces a much smaller percentage increase in output per man-shift and a small increase in mechanization may in fact be accompanied by a slight *decline* in output per man-shift. The high percentage of mechanization in Scotland makes further improvement in shift output difficult, unless, of course, improved methods of mechanization be adopted.

[2] As a percentage of output in 1913, that in Scotland was 75·9 per cent in 1937 and 58·4 per cent in 1944, but in Great Britain 83·7 and 70·7 per cent respectively.

Fig. 34

COLLIERIES IN THE CENTRAL, FIFE AND MIDLOTHIAN COALFIELDS OF SCOTLAND, 1938

Map drawn from data in *List of Mines*. The symbols show the size of each colliery in proportion to the number of men employed. The map does not give an *exact* index of relative output owing to differences from pit to pit in output per man employed. The pecked line marks the limit of the exposed Coal Measures. The large number of pits in Scotland in formations older than the Coal Measures is most noticeable.



Industrial Revolution in Scotland, is not now the dominant focus of coal-mining activity, though it still remains the chief focus of industry. Of the total production in Scotland in 1937, 23 per cent was exported abroad or used for bunkering ships engaged in foreign trade and 15 per cent was shipped coastwise.[1] Export abroad was chiefly to the Baltic and North Sea areas, and this was true of west as well as of east Scottish ports, with the Mediterranean and North America as areas of minor importance for the western ports. The space-relations of Scottish coal exports are thus chiefly eastwards.

The North-east Coast, like the Scottish fields, has thinner seams than the average for the country as a whole, and this is especially true of the Northumberland part of the field which exhibits stratigraphical similarities with Scotland. The North-east field, again like the Scottish, has relatively shallow pits. Unlike the Scottish fields, however, the coals are often of first-class quality, Durham coking coals being the best of their kind in Britain and the Wallsend seam yielding first-class house coals. The steam coals of Northumberland and East Durham are not, however, of outstanding quality. Perhaps because of the relatively undisturbed character of the field and despite the relatively shallow workings, the mines are larger than in Scotland. In physical characteristics the Northumberland part thus presents many analogies with Scottish fields and the Durham part with average conditions in England and Wales. There is a marked difference between the two parts of the field in degree of mechanization: in Northumberland coal-cutting machinery is used as extensively as in Fife, and for similar reasons, but in Durham the proportion of the output cut by machine and the proportion handled by mechanical conveyors is far below the average of the country as a whole. The reason for the low degree of mechanization in Durham is probably connected with the thicker seams as compared with Northumberland and the consequential lack of urge to introduce machinery, and perhaps with the non-mechanized bord and pillar system of working which has persisted in Durham more than elsewhere,[2] but whatever the cause, output per man-shift is higher in Northumberland than in Durham, being almost equal to the national average in Northumberland, but being below it in Durham. Owing to low wage-rates during the inter-war period, wage costs on the North-east Coast were lower than in any other of the major coalfields of the country. Total costs of production, taking into account the value of the allowances received in kind, were then substantially below the national average in Northumberland and equal to it in Durham, but by 1945 costs in Durham, and by 1948 in Northumberland, had come to exceed average costs in Great Britain. For a long

[1] In 1949, 12 per cent was exported abroad and to Ireland or used for foreign and coastwise bunkers.

[2] *Durham Coalfield, Regional Survey Report* (1945), Ministry of Fuel and Power, p. 24. The Reid Committee declares that the *intensive* bord and pillar is capable in suitable conditions of a higher output per man-shift than any other method.

period the costs of production have been below those of South Wales. The advantage of the North-east Coast relative to other fields, however, is less than formerly.

The North-east Coast field was able during the inter-war period to invade markets in Britain when these were supplied by fields with a higher cost of production, and in particular has been able to increase its share of the London market.[1] This would, however, have been impossible but for the coastal position and the lesser cost of long-distance coastwise transport as compared with long-distance rail transport. Yet, despite these lower costs of production, the output of the North-east Coast field declined, to only a small extent in the case of Northumberland, but substantially in the case of Durham. Durham has a cost advantage to-day only as against Cumberland, Lanarkshire, South Wales, and Kent. Decline has been due to decreased export and to decreased activity during the inter-war years in the iron and steel industries, which, after coal, constitute the industrial staple of the region. The Industrial Survey of 1932 attributed decline in output up to that date equally to these two factors.[2] But by 1938, with greater activity in the iron and steel industries owing to reorganization and rearmament, and with a still further fall in export abroad, decline in output had come to be due chiefly to greatly decreased shipment abroad which in 1938 was little more than half of what it had been in 1913. Coastwise shipments, however, had increased and, together, export and coastwise shipments accounted for almost exactly the same proportion of the total output in 1938 as in 1913 (62·8 and 62·0 per cent respectively). Nearly two-thirds of the output was thus exported away from the district.[3] The destination of coal exports from the North-east Coast, like those from Scotland, is mainly eastwards, 80 per cent of the total in 1937 going to lands around the shores of the Baltic and North Sea, although the not unsubstantial proportion of 17 per cent went to the Mediterranean. The decline in coal output on the North-east Coast caused severe unemployment, especially in Durham, with higher costs of production than Northumberland.

The South Wales coalfield is larger than either those of Scotland or of the North-east Coast. It also has generally thicker seams, thicker than the average for Great Britain as a whole. The quality of coals mined in South Wales is generally high, particularly in respect of steam coals and anthracite. In depth of working and in

[1] Jones, Cartwright, and Guénault, op. cit., pp. 46–7. The tables in the *Statistical Digest, 1945* (1946, Cmd. 6920), gives quantities thus sent to other parts of the country—London and the South-east receiving the greatest quantities, followed by the North-west of England and Scotland.

[2] *An Industrial Survey of the North-east Coast Area* (1932), pp. 92–4.

[3] The position in 1945 was as follows. Output of saleable coal 32·6 million tons. Consumed in region, 16·1 million tons. Shipments abroad and bunkers, 2·5 million tons. Transported to other parts of Britain, 14·0 million tons. Quantities for 1949 were 38·1, 17·7, 5·0 and 18·1 respectively.

size of mine,[1] South Wales presents characteristics similar to the average for the country as a whole. But in one physical respect, that of great disturbance due to faulting, South Wales is at a disadvantage. Seams are often steeply inclined and discontinuous. Physical disadvantages in Scotland and in Northumberland in the form of thin seams have been countered by a high degree of mechanization, but in South Wales a very small percentage of coal is cut by machine. Only the small fields of the Black Country, Bristol, Somerset, and Kent, had in 1945, a lower percentage. It is commonly argued that the South Wales coal seams are not suited to coal-cutters, but it may also be added that the relatively thick seams have not provided the same urge to the installation of coal-cutting machines on the part of the management as have the thin seams of Scotland and Northumberland. Coal conveyors, however, are used much more extensively. Despite the relatively thick seams and the average depth of mine, but in harmony with the disturbed character of the field and the low degree of mechanization, South Wales has a low output per man-shift, lower than for any other of the major coalfields.[2] The relative position of the South Wales field in this respect has deteriorated relative to other fields, for there was an improvement between 1923 and 1938 of only 3·5 cwt. per man-shift as compared with 4·9 cwt. for Great Britain and 5·6 cwt. for the group comprising Lancashire and North Staffordshire. Costs of production are well above the national average and among the highest in Britain.[3] The South Wales coalfield, therefore, is a high-cost field, particularly when compared with its British competitor in the export trade (the North-east Coast), and still more when compared with its continental competitors. Some little compensation is found because of the high quality of the coals and the higher prices at which they are sold as compared with their competitors in export markets. Before and during the early years of the late war the credit balance per ton was the lowest of all British fields for which separate returns were made, and during recent years when some fields had a debit balance, that of South Wales was the greatest[4] among the larger fields.

Like the North-east Coast field, South Wales is primarily an exporter. In 1913, foreign shipments, including foreign bunkers, amounted to 61·4 per cent of the total output and coastwise shipments to 7·0 per cent. By 1938 foreign shipments had fallen to 49·1 per cent of output, though coastwise shipments had risen slightly

[1] There is no certain evidence that output per man-shift increases with size of mine. South Wales is comparable in this respect with Scotland and with Durham, and is unlike the Yorkshire–Derby–Nottingham field.

[2] Output per man-shift in South Wales was $1\frac{5}{8}$ cwt. below the national average in the early 'twenties, $2\frac{3}{4}$ cwt. below since 1931, and 5 cwt. below in 1945.

[3] Only Cumberland has both a lower output per man-shift and higher costs of production per ton.

[4] There was a substantial improvement in 1949 as compared with previous years. The central parts of the field (Rhymney, Rhondda, Aberdare) had a credit balance.

to 8·6 per cent. Of the foreign export in 1938, 41 per cent went to Baltic and North Sea ports, 31 per cent to the Mediterranean, and 25 per cent to the Americas. The space-relations of South Wales are thus predominantly westwards, the Mediterranean being entered at its western end, and, in fact, export to Baltic and North Sea ports was chiefly to France, which does not properly belong to this group of export markets. A comparison of the changes between 1913 and 1937–8 in South Wales with the changes on the North-east Coast in the same period is instructive. In 1913 South Wales shipped a

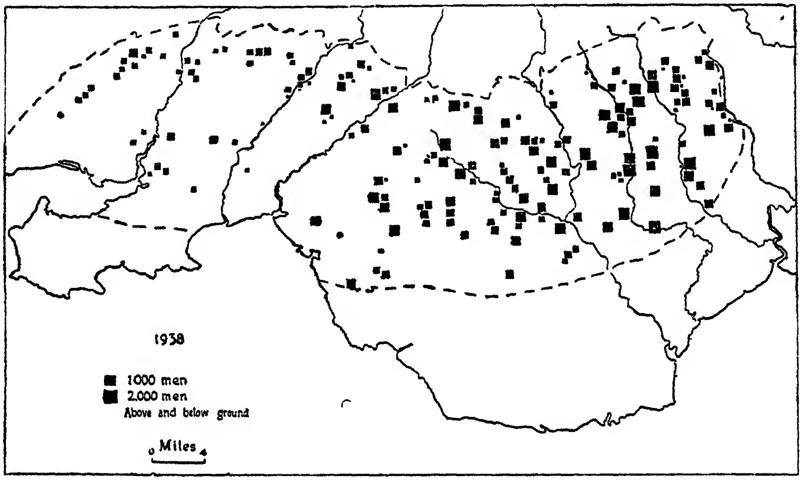


Fig. 36

COLLIERIES IN SOUTH WALES AND MONMOUTH IN 1938

The pecked line marks the limit of the exposed Coal Measures. See note under Fig. 34.

somewhat greater percentage of total output than the North-east Coast, but in 1938 a somewhat smaller percentage. The foreign export of both has declined, but South Wales has been unable to recompense herself for this decline by a growth of coastwise traffic as the North-east Coast, on the other hand, has been able to do. Coastwise traffic has always been a minor element in coal shipments from South Wales. Total output in South Wales had by 1937 declined further than on the North-east Coast—by 33 per cent as compared with 15 per cent. In the old staple markets around the European coasts South Wales has lost more than has Durham and Northumberland, a loss which may be correlated with its higher costs of production.[1] The newly developed market in Canada for South Wales

[1] The greatest loss has been in steam coal, and least in household coal, and there has been an increase in the export of anthracite. Steam coal constitutes the bulk of the coal exported (*An Industrial Survey of South Wales* (1932), p. 31).

anthracite is, of course, non-competitive with the North-east Coast.[1] As a result of high costs of production and of the elimination of much of the export trade during the late war, output in South Wales has fallen to three-fifths of the level of 1937, the greatest percentage fall of all the major coalfields.

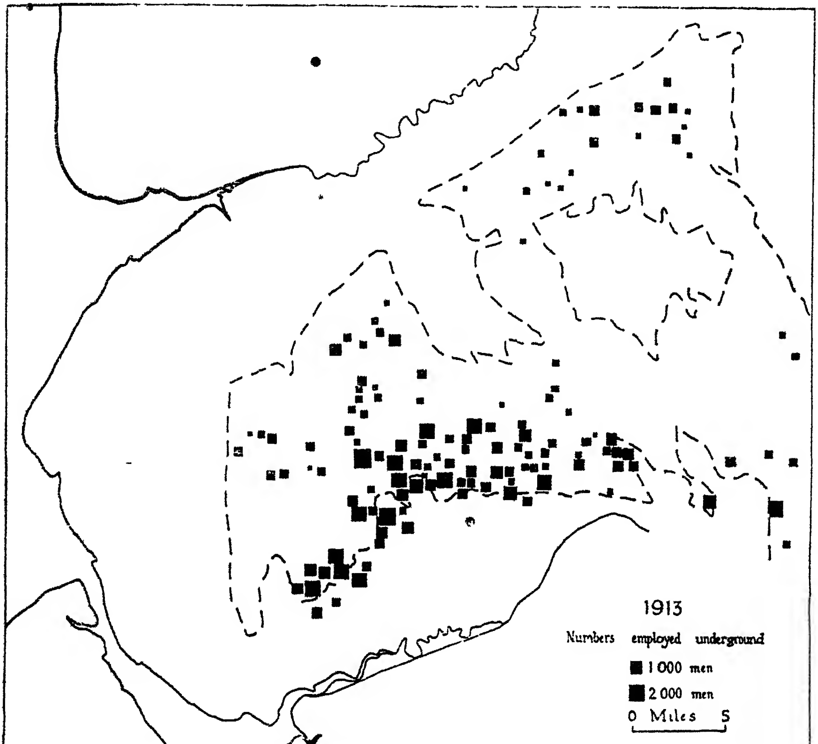


Fig. 37

COLLIERIES IN LANCASHIRE IN 1913

The pecked line marks the limit of the exposed Coal-Measures. See note under Fig. 34. Limitation to numbers employed underground gives a closer approximation to an exact index of output.

Anthracite coal-mining in South Wales is very different in many respects from bituminous coal-mining, and it has exhibited a different trend.[2] While in the last two decades the production of bituminous coal in South Wales has declined, that of anthracite has increased, from 4·8 million tons in 1913 to 6·1 in 1934, though it

[1] Export abroad during the late war was greatly reduced and South Wales coal was sent to other parts of Britain. In 1945 output in Wales was 23·3 million tons, and consumed within region, 13·1 million tons. The deterioration of the standard of production in South Wales receives a good deal of attention in *South Wales Coalfield, Regional Survey Report* (1946), Ministry of Fuel and Power.

[2] A. E. C. Hare, *The Anthracite Coal Industry of the Swansea District* (1940).

fell to 5·5 in 1938. During the 'thirties particularly its trend was the reverse of that of bituminous coal production. Anthracite serves an entirely different market—central heating, electricity generation, producer-gas making, malting, cement-making, and lime burning—and for these uses, particularly the former, consumption is growing.

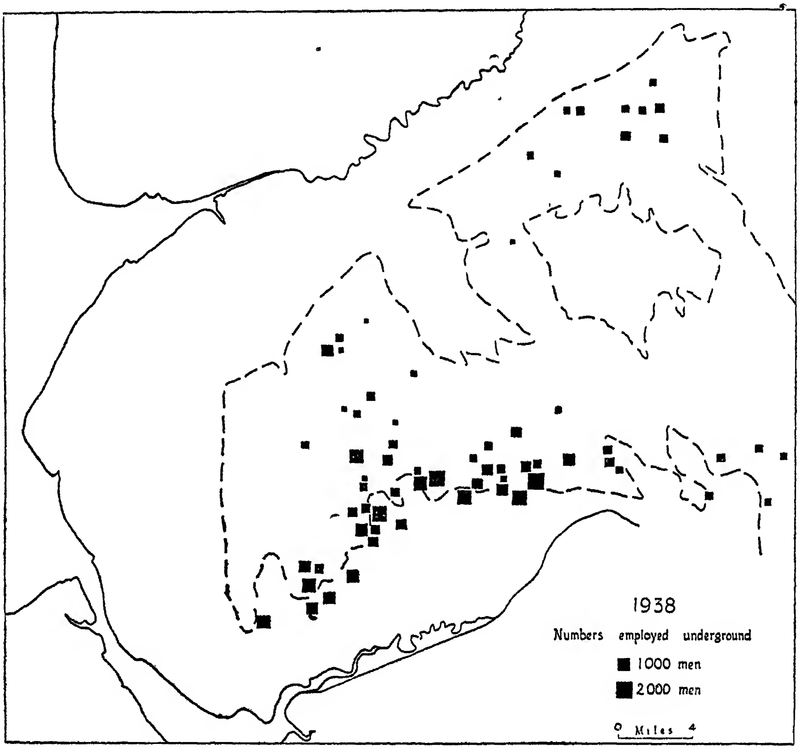


Fig. 38

COLLIERIES IN LANCASHIRE IN 1938

The pecked line marks the limit of the exposed Coal Measures. See notes under Figs. 34 and 37.

Prior to the last two decades the market served was on the European continent, but since that time Canada has been added, partly owing to the decline of American anthracite production and partly owing to the Ottawa Agreements.[1] Anthracite mining is different not only in its trend, but also in its geographical distribution and in its economic structure. The anthracite mines are in the west of the South Wales coalfield, in that part which is the most highly disturbed.

[1] Hare, op. cit., pp. 24–7. See also *The Second Industrial Survey of South Wales*, vol. I (1937), p. 40.

Mining, therefore, is difficult, and has always been on a relatively small scale though the average size of colliery is increasing.[1] Because of the great degree of disturbance, costs of mining are high and output per man-shift low, being only 17 cwt. in 1939.[2] But employment is relatively regular and prices are high, partly perhaps because

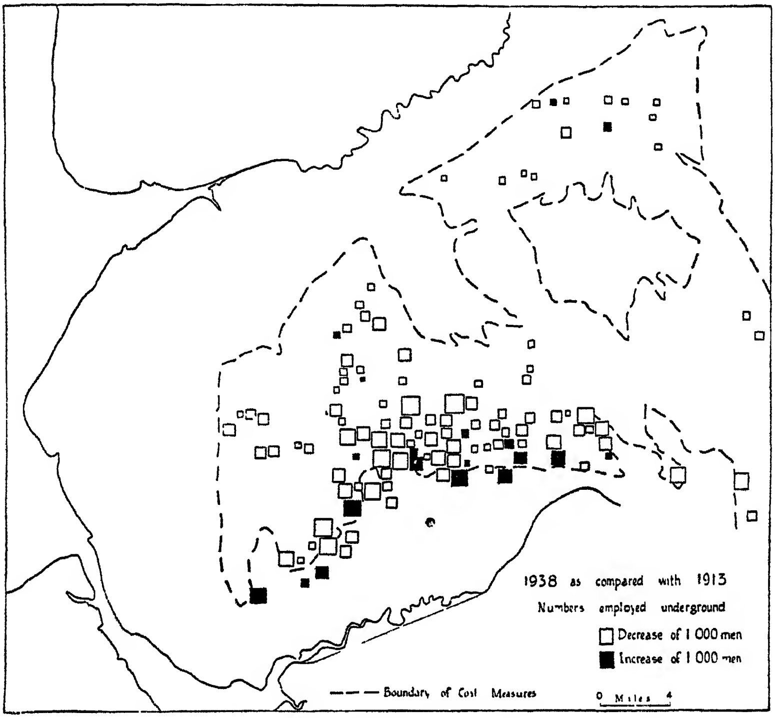


Fig. 39

CHANGES IN COLLIERY EMPLOYMENT IN LANCASHIRE BETWEEN 1913 AND 1938

The symbols show the extent of change in numbers employed underground at each colliery. Decreases, whether of pits closed down or of pits with decreased employment, are shown by hollow squares· increases, whether of new pits or of pits with increased employment, are shown by blacked-in squares. Size of symbol increased as compared with Figs. 37 and 38 in order to clarify the map. See also note under Fig. 34.

of the monopoly control, and annual miners' earnings are higher than in the rest of the coalfield.

[1] While for the field as a whole the size-group contributing most to total employment in 1938 was that employing 500–999 men underground, in the western part the most important size-group was that employing 1–499 men underground. From the *List of Mines* Hare calculated that the average number employed was 300 persons in 1923 and 403 in 1938 (Hare, op. cit., p. 65).

[2] Hare, op. cit., p. 68.

The Lancashire–Cheshire field was unfortunately merged statistically for many purposes with the North Staffordshire field until the reorganization of statistical returns by the Ministry of Fuel and Power, and the two do not present identical characteristics. The output of Lancashire was declining during the inter-war period, but

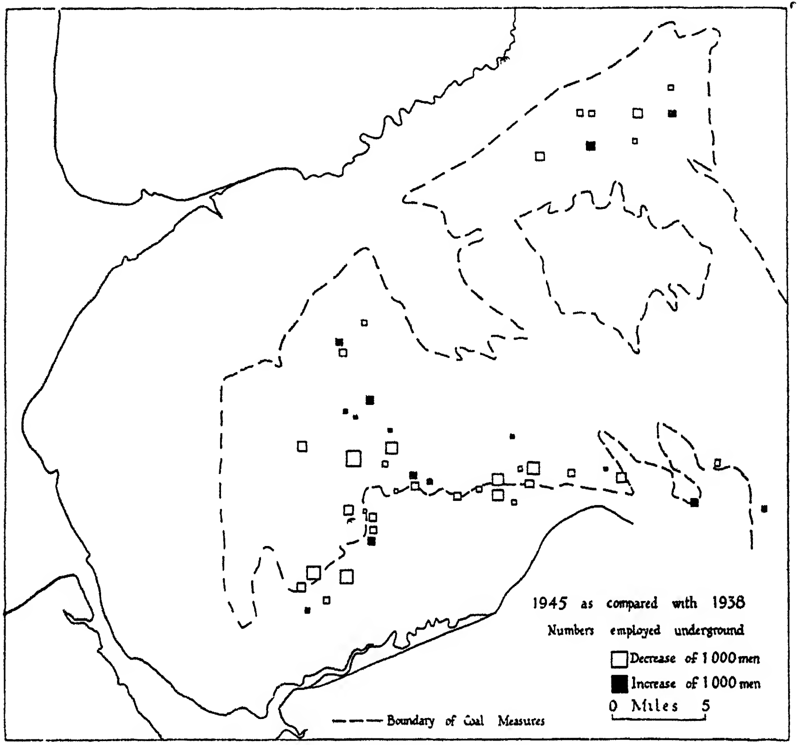


Fig. 40

CHANGES IN COLLIERY EMPLOYMENT IN LANCASHIRE BETWEEN 1938 AND 1945

See notes under Figs. 34 and 39. There was noticeably little change between these years in contrast to the magnitude of change between 1913 and 1938. It would appear that the 1938 distribution of pits still holds in its general features.

that of North Staffordshire increasing; in 1919 Lancashire contributed 77 per cent of the combined total output, but in 1938 67 per cent and in 1945 65 per cent. The reserves of the two fields, as estimated in 1905, are comparable, being 4,239 million tons for Lancashire and 4,272 for North Staffordshire.[1] The reserves of the Lancashire field are being depleted, therefore, at a much more rapid rate. There has been a greater increase in output per man employed

[1] Exclusive of the small Cheshire and Cheadle fields respectively.

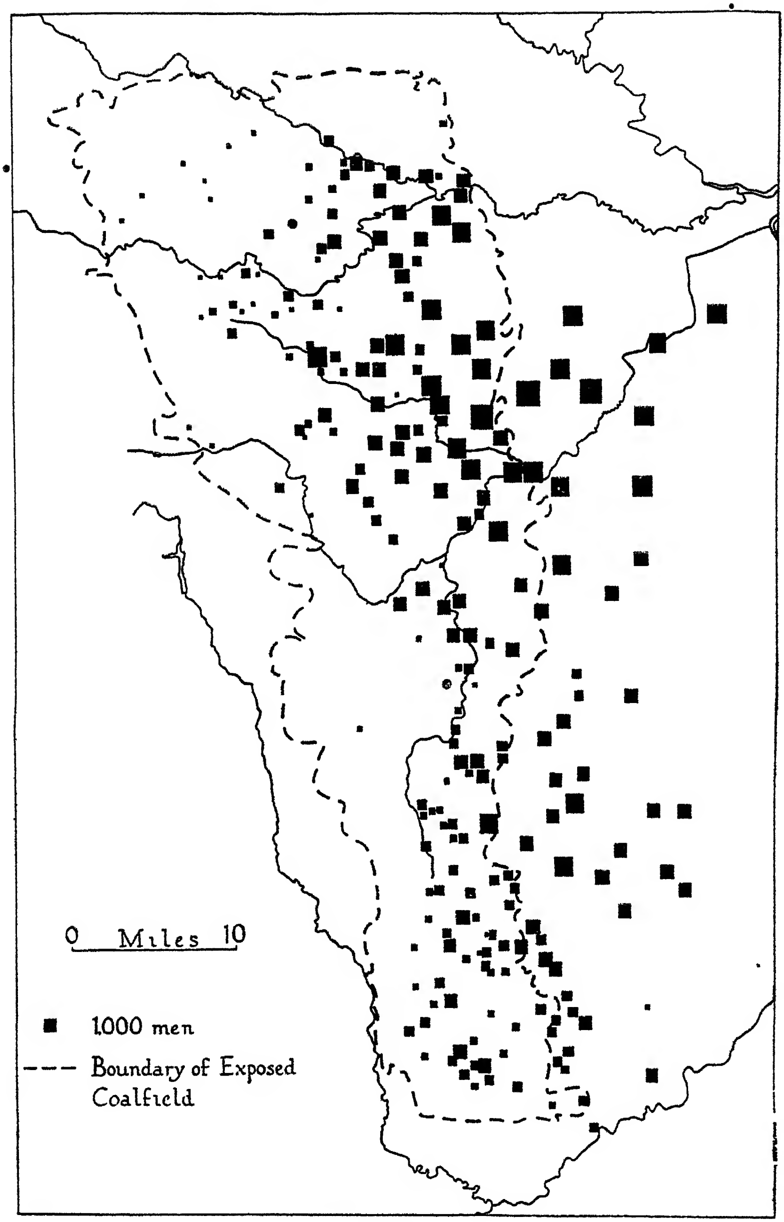


Fig. 41

COLLIERIES IN THE YORKSHIRE, DERBYSHIRE AND NOTTINGHAMSHIRE COALFIELD IN 1938

See note under Fig. 34.

underground during the last two decades in North Staffordshire than in Lancashire–Cheshire. This difference may be attributed in part to lesser obsolescence in North Staffordshire and in part to greater mechanization, for 92 per cent of the output in 1938 was cut by machine as compared with 68 per cent in Lancashire–Cheshire, but the gap has been closing and the percentages in 1945 were 92 and 88 respectively. Output per man-shift is higher in North Staffordshire than in Lancashire–Cheshire. In Lancashire, Cheshire, and North Staffordshire, the thickness of seam mined is similar to the average for the country as a whole, but the average pit is considerably deeper. Of the major coalfields only South Yorkshire has a greater average depth of mining. The average size of mine in Lancashire is below, and in North Staffordshire about equal, to the national average. According to the 1924–5 returns, there is no indication of output per man-shift increasing with size of mine. The Lancashire field is greatly disturbed by faulting, and mining difficulties greatly increased thereby.[1] Moreover, the average thickness of seam as applied to Lancashire gives a rather false impression, for the better seams are partly exhausted and most of the thicker seams left are of poor quality. On balance the Lancashire field is thus physically in a rather disadvantageous position, but this is in process of improvement, as a result partly of intense mechanization and partly of concentration of production on the more efficient pits.[2] The costs of production per ton are high in Lancashire, though they are now surpassed by costs in South Wales. Lancashire is thus unquestionably a high-cost district, though it is true to say that, judged against the background of all the fields of Great Britain, its relative position is improving rather than deteriorating.[3] But the Lancashire field is

[1] This may perhaps be indicated by the high proportion of men employed in making and repairing roads underground, in 1924 being 26 per cent of the total employed underground as compared with 19 per cent for Great Britain and 15 per cent for Derby and Nottingham (Royal Commission on the Coal Industry (1925), *Report*, vol. III, pp. 197, 204, 208).

[2] There was a good deal of large-scale amalgamation of collieries from 1928 onwards, though these amalgamations up to 1932 had probably more effect on production costs for ancillary enterprises than for coal-mining itself (*Industrial Survey of the Lancashire Area* (1932), pp. 172–4). Amalgamation has, however, permitted concentration of production on the more efficient pits and some replanning of underground workings of adjacent pits. Such amalgamation took the form of sub-regional amalgamations—the Manchester group, the Wigan group, the Burnley group—which makes possible such replanning of workings of adjacent pits. In 1935 a scheme for complete central selling came into operation in the Lancashire field, and this secured higher prices for Lancashire coal, operating therefore to the satisfaction of the coal owners.

[3] The *Industrial Survey of the Lancashire Area* (1932) drew attention to 'the widening gap that tends to appear between costs in Lancashire, Cheshire, and North Staffs, and costs in competitive fields'. This was true at that date, but, owing to the improvement in Lancashire's position, it is not true to-day. The chief competitive field is the Yorkshire–Derby–Nottingham, whose position relative to the country as a whole also is improving, but the two improvements have been parallel.

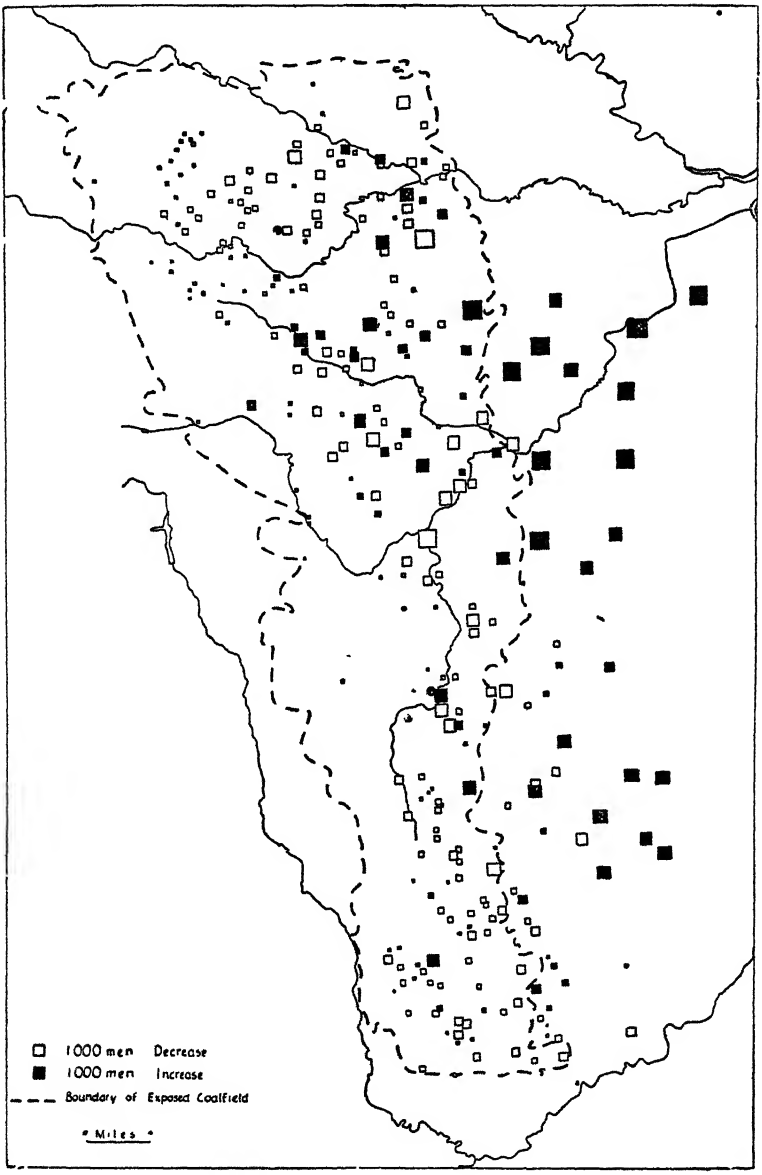


Fig 42

CHANGES IN COLLIERY EMPLOYMENT IN THE YORKSHIRE, DERBYSHIRE AND NOTTINGHAMSHIRE COALFIELD BETWEEN 1913 AND 1938

See notes under Fig. 34 and 39. In this map the scale of symbols is identical with that of Fig. 41.

now unable to supply the whole of the Lancashire–Cheshire market,[1] and coal is imported from the Yorkshire–Derby–Nottingham, the North Wales, and the North Staffordshire fields and occasionally by rail from Durham and by coaster from the West of Scotland and South Wales.[2] The Lancashire field is mainly concerned with inland supply—slack for steam-raising in textile mills, graded coal for household use, coking coal for gas and coke, lump coal for railway locomotives, and small coal for electricity generation. Many Lancashire collieries have been part of concerns engaged in other activities such as iron and steel manufacture or coke-making. The area served with house coal extends from the southern margins of the Lake District to Southern Salop. There were, before the war, agreements with neighbouring coalfields regarding their share of the Lancashire market.[3] North Staffordshire coal is consumed partly in the Potteries for domestic and industrial purposes and partly in neighbouring districts.[4] There is a little export mainly from the St. Helens part of the Lancashire field. Exports from Lancashire are merged with exports from North Wales, North Staffordshire, and Cumberland under the heading of north-western ports. The export disposals from these districts, however, on the eve of the late war were insufficient to supply the export actually recorded, and it is probable that some coal is exported from the Yorkshire–Derby–Nottingham field via north-western ports.[5]

The Yorkshire–Derby–Nottingham field is in many ways unique among the coalfields of Britain. Including the concealed field, it is the largest of all. It has been less disturbed by faulting than any other major field and its seams are very regularly developed. Colliery planning and development is thus a comparatively straightforward task. These are unique features and, combined with its other advantages, they are largely responsible for the increasing importance in the field in the total output of Britain. Taking the coalfield as a whole, the average thickness of seam worked is greater than the national average. This is not true for the western parts of the field which consist of Lower as well as of Middle Coal Measures, but it

[1] The North-western region of the Ministry of Fuel and Power (Lancashire, Cheshire, Cumberland, and Westmorland) in 1945 produced 12·0 million tons, but consumed 28·0 million tons.

[2] Jones, Cartwright, and Guénault, op. cit., p. 75.

[3] A. Roberts, 'Changes in the Marketing of Coal by the Coal Mines Act of 1930', *Journal Manchester Statistical Society* (1938), p. 15. Coal Mines Act, 1930, *Report* under Section 7 under Part I of the Act (1937), Cmd. 5474, p. 8.

[4] In 1915–17 about one-third of the output of North Staffordshire went by rail to stations beyond the system of the North Staffordshire Railway, about one-quarter by rail within the company's system and the rest was presumably delivered by road.

[5] Export disposal refers to the coal for export actually disposed of, export allocation the coal allocated to the district for this purpose. Total allocation includes not only export and inland supply allocation, but also some additional amount for coal used by the collieries and by miners and for dirt discarded in screening and cleaning.

is pre-eminently true for the eastern parts, where the Barnsley is often the only seam worked. The average depth of mining is less than the national average in Derby and Nottingham, about equal to it in West Yorkshire, but considerably greater in South Yorkshire, where no less than 40 per cent of the total output in 1924 was won from seams over 1,800 feet below the surface. The great depth in

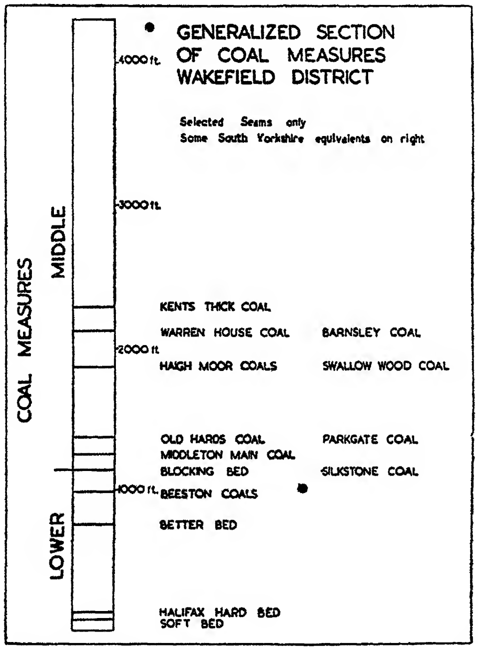


Fig. 43

GENERALIZED SECTION OF THE COAL MEASURES IN THE WAKEFIELD DISTRICT (WEST YORKSHIRE)

South Yorkshire is due to the large number of collieries in that district working the concealed field. The average size of collieries for the field as a whole is considerably greater than the average for Great Britain, and it is greatest of all in South Yorkshire, which is surpassed in size of colliery only by the new coalfield of Kent, where the operating unit has been on a large scale from the very start.[1] In South Yorkshire no less than 80 per cent of the total number employed underground in 1938 were in pits having 1,000 men and over beneath the surface. As the pits are large, the time taken to get

[1] For the field as a whole the size-group contributing most to employment is that with 1,000–1,499 men underground, but for South Yorkshire separately it is that employing 2,000 and over underground.

from the shaft bottom to the working face was a little above the average.

In this field there is an increased output per man-shift with increasing size of mine, and this is true of every part of the field, separately as well as collectively. According to the 1924–5 returns, it is the only coalfield in the country of which this is unquestionably true, and it is probably the lack of disturbance in the field and the even and unbroken disposition of the seams that are responsible, for these conditions permit systematic layout and large-scale planning. In badly faulted fields the same systematic planning is impossible, and there is not the same advantage to be gained from large operating units. It is clear that the Yorkshire–Derby–Nottingham field possesses substantial physical advantages in respect of mining over most other fields in the country. These advantages are expressed in a high output per man-shift;[1] in the case of Derby and Nottingham, an output which is the highest for any area except the small field in Leicester and South Derby. The higher output per man-shift in Derby and Nottingham than in Yorkshire may be due to a greater degree of mechanization,[2] but the high output for the field as a whole is clearly the result primarily of favourable physical factors. Costs of production are low because of this high output per man-shift, and they are now the lowest in the country except those of the small field in Leicester and South Derby.[3]

On account of these physical advantages the Yorkshire–Derby–Nottingham field had a greater output in 1937 than in 1913, unlike any other of the *major* coalfields of the country. It is an area of inward migration of coal-miners from fields with a declining output. The increase is not general throughout the field, for it comes from the concealed part of the field, and there was a decline in West Yorkshire, which is almost wholly exposed. In 1913 the field as a whole contributed 26 per cent of the total output of Britain, but in 1937 32 per cent and in 1945 37 per cent. This increase in output, due to physical advantages, has been facilitated by its geographical position. It has always been concerned mainly with the home

[1] From 1932 to 1935 Yorkshire had an output 3 cwt. above the national average, and in 1938 and the first half of 1939, 2¾ cwt. above. From 1932 to 1935 Derby and Nottingham had an output nearly 4½ cwt. in excess of the national average and in 1938 and 1939, 5¾ cwt. In 1943 output per man-shift was 1·03 tons in Great Britain, 1·48 tons in Nottingham, 1·34 in North Derby, 1·17 in South Yorkshire, and 0·99 in West Yorkshire.

[2] Percentages of coal cut by machine in 1943 were 67 per cent in Great Britain, 96 per cent in North Derby, 82 per cent in Nottingham, 69 per cent in South Yorkshire, and 68 per cent in West Yorkshire.

[3] Until the late 'thirties Northumberland and Scotland had lower costs. In the Yorkshire–Derby–Nottingham field lower costs are especially marked in respect of costs other than wages, e.g. in Derby and Nottingham in the second quarter of 1939 the cost of stores and timber per ton of coal raised was 1*s.* 7*d.*, but in Great Britain as a whole, 2*s.* 3*d.* Again, in 1924 only 15 per cent of men employed underground were engaged in making and repairing roads, as compared with the national average of 19 per cent. These are direct results of the regularity of the coal seams.

market, a market which has fluctuated with the trade-cycle, but which has exhibited no long-term decline. Its share of the home market, in fact, has increased from 35 per cent in 1913 to 42 per cent in 1937, an increase which affected primarily Lancashire. Lancashire has imported Yorkshire coal in quantity to compensate for the declining local output. Export abroad is of much less significance. Exports by 1937 were nearly halved, as total exports from the country as a whole. Export disposals of the Yorkshire–Derby–Nottingham field on the eve of the late war exceeded actual exports from Humber ports and it would seem that there was some export of coal via north-western ports, for export disposals from the north-west fields were less than actual exports from north-western ports. Exports abroad from Humber ports were then mainly and increasingly to the Baltic and the North Sea, but, like the North-east Coast and Scotland, there was a not inconsiderable minor market in South America.[1]

In several respects the West Yorkshire section is distinct from the rest of the field and presents analogies with the Lancashire coalfield. In both cases output is declining because of obsolescence, for they have both long been worked in association with the urban industrialism of West Yorkshire and of eastern Lancashire respectively. In both cases production is insufficient to supply the whole of the local market, and in both cases coal is imported from other districts, notably from South Yorkshire. There are certain differences, however, for the West Yorkshire field in its eastern parts has some of the characteristics of South Yorkshire, implying that it is easier and cheaper to work owing to relative absence of faulting.[2] It is only the western part of the West Yorkshire field that exhibits real comparability with Lancashire. Output per man-shift is thus higher in West Yorkshire than in Lancashire.

6 - The Midland fields present considerable variety. They fall into two groups—the first, Cannock Chase, Leicester, and Warwick; the second, the Black Country, Coalbrookdale, and Forest of Wyre. The second group presents a number of comparatively archaic features. The Cannock Chase, Leicester, and Warwick fields, taken together, have comparatively thick seams and comparatively shallow workings when compared with the national average. Of all the coalfield groups this has the greatest average thickness of seam, but both Scotland and the North-east Coast have shallower pits. In size of mine they appear to have pits slightly larger than the national average, being relatively new fields. According to the returns of 1924–5,

[1] The following are the figures for 1938: export disposals of the Midland Amalgamated District, 6·9 million tons; exports from Humber ports, 5·8 million tons; export disposals of Cumberland, Lancashire–Cheshire, North Staffordshire, and North Wales, 0·5 million tons; export from north-west ports, 2·5 million tons.

[2] For the economic structure of the industry in the two districts, see Jones, Cartwright, and Guénault, op. cit., and the *Reports* of the Coal Mines Reorganization Commission to the Secretary for Mines.

however, there is no evidence of increasing output per man-shift with increasing size of mine. In most of their physical characteristics this group of fields exhibits relatively advantageous conditions in respect of ease and cost of mining. Output per man-shift is now higher than the national average, except only in Cannock Chase, and costs of production are well below the national average, except Cannock Chase. Only Nottingham and North Derby have such low costs. These conditions of high output per man-shift and of low costs of production are of quite recent development and they are particularly pronounced in Leicester and South Derby, whose costs of production had come to be the lowest of all.[1] The coals are almost entirely house, manufacturing and steam coals, the former predominating. It is not only the Midland market, however, which is supplied, for these fields share with the North-east Coast and with the southern part of the Yorkshire–Derby–Nottingham field the coal market of London and South-east England.[2] In the five years, 1930–4, for example, of the annual average of 18·46 million tons brought into London, 6·91 were brought by rail, 11·51 by sea, and 0·04 by canal. The coastwise traffic came mainly from the North-east Coast, but the rail and canal traffic from the Yorkshire–Derby–Nottingham field and from the fields of this Midland group. Some anthracite is also brought into London from South Wales.

The Black Country field is now largely worked out and its output is declining. It was 3 million tons in 1913, 1·4 in 1937, and 0·9 in 1945. The scale of mining is small: in 1938, of forty pits twenty-eight employed less than fifty men underground and only four over 100 men underground. The small pits are surface scratchings and ephemeral; the larger pits are away from the exposed field and sunk through post-Carboniferous formations. The life of the field has been shortened by irregular individualistic working which has left a good deal of coal underground unnecessarily, and which has prevented the effective draining of the field.[3] The practice, whenever a fault was encountered, was to abandon the working and to sink a new shaft beyond the fault.[4] The coals worked are entirely house, manufacturing, and steam coals, chiefly manufacturing coals. The degree of mechanization is very low—only 6 per cent of the output in 1938 and only 17½ per cent in 1945 being cut by machine. Nevertheless, output per man-shift in 1924–5 and output per person employed in 1938 were both above the average of Great Britain; but it had fallen below by 1943. The Thick Coal is still the main seam

[1] For this group of fields as a whole output in 1949 was greater than that of 1938, though in Great Britain it had fallen by a quarter.

[2] Prices quoted in London include *inter alia* those for Best Silkstone, Derby Brights, Nottingham Best Brights, and Nottingham Small Nuts.

[3] G. C. Allen, *The Industrial Development of Birmingham and the Black Country* (1929), pp. 384–6.

[4] J. W. F. Rowe, *Wages in the Coal Industry* (1923), p. 27.

worked alike in the surface scratchings and in the larger pits in the concealed field.

The Cumberland field is badly disturbed by faulting and in size of mine is below the national average.[1] Detailed information on thickness of seam and on depth of mining is not available, but it is clear that the relative position of the field as judged by output per man-shift and cost of production per ton is very low. Despite a high degree of mechanization (73 per cent in 1944), only the Bristol and Somerset fields have a lower output per man-shift. Adding to the effects of these high costs, there have been restrictions in Cumberland's two chief markets—the iron and steel industry and Ireland. Together these used to take two-thirds or more of the total production.[2] Both, however, have suffered decline. The iron and steel industry was depressed during the inter-war period and trade with the Irish Free State was restricted during the early 'thirties, when it imported Polish coal in place of British. The coals are of medium rather than of first-class quality, and the best coke is brought in by rail from Durham.

The most important part of the North Wales field is that in Denbigh, and in this district coal-mining has become concentrated. Of mines employing over 100 men underground, there were in 1913 six in Flint and nine in Denbigh, but in 1936, one in Flint and seven in Denbigh. It is in the Wrexham–Ruabon district that mining is now focused and the north-western arm of the field, in Flintshire fronting the Dee estuary, has only one non-ephemeral working.[3] Output had not declined much since 1913, and in 1937 was the same as in 1919.[4] The degree of mechanization is a little above the national average, and there are some large pits,[5] but there is a low output per man-shift. It has been able to maintain its output for it is not to any large extent dependent on shipment to Ireland, and there is a substantial market close at hand in Merseyside and in North Wales generally. While Liverpool uses Lancashire coal, Birkenhead uses coal from North Wales.

The Forest of Dean is isolated in the midst of woodland. Its output of 1·4 million tons in 1937 represents only a moderate decline from its 1913 level, but it had fallen to 0·9 million tons by 1945. The average colliery is on a small scale: of thirty pits in 1938 only

[1] The average for mines employing fifty or more underground is 406, as compared with 556 for Great Britain.

[2] The iron and steel industry consumes raw coal as well as coke. See J. Jewkes and A. Winterbottom, *An Industrial Survey of Cumberland and Furness* (1933).

[3] Of the thirty-one workings in 1913 and 1936 which employed under a hundred men underground, only four were in operation in both years. This ephemeral character is especially true of the north-western arm. There are, however, considerable developments in progress at the Point of Ayr Colliery.

[4] Output was 3·5 million tons in 1913, 2·8 million tons in 1919, and 2·8 million tons in 1937. By 1945 it had fallen to 2·1 million tons.

[5] The most important size-groups from the point of view of the employment they provide are those employing 1,000–1,499 and 2,000 men underground.

eight employed fifty men and over underground. The Coleford High Delf is the most important seam worked, and it usually yields a steam coal. Most of the house coal is from seams above it. The degree of mechanization and output per man-shift are lower and costs of production a little higher than the national average, but there is some fluctuation from year to year in its precise relative position. A small proportion of the output is shipped abroad, but the home market is its primary concern. The Forest of Dean supplies parts of the West Country, the Stroud valley in the Cotswolds being an example. It is competitive with the Midland fields rather than with South Wales.

The East Kent field is the newest of British coalfields. It has been worked for only a quarter of a century, output reached 2 million tons in 1934, but it subsequently fell to 1·8 in 1938 and 1·4 in 1945. Output is now rising again: it was 1·6 million tons in 1949. Being a new field and working coal concealed under a thick post-Carboniferous cover, the pits are all large, the average employing 1,360 men underground in 1938. The degree of mechanization is the lowest of all fields, only 10 per cent in 1945.[1] Output per man-shift is below the national average, and costs of production are high, being surpassed only by South Wales and Cumberland in 1945. These high costs of production may be responsible for the declining output. The market mainly supplied is electricity generation and industry generally.

It will be clear from the foregoing that a large and general distinction may be drawn between those fields which have exported a substantial proportion of their output and those which are almost completely dependent on home consumption. The North-east Coast, South Wales, Cumberland, and the coastal fields of Scotland constitute the export group, and Lanarkshire, Lancashire, North Wales, Yorkshire–Derby–Nottingham, North Stafford, Leicester, Warwick, Cannock Chase, the Black Country, Salop, the Forest of Dean, Bristol, Somerset, and Kent constitute the home group. In 1938 38 per cent of the output of the export group was exported abroad as cargoes or as bunkers on ships engaged in foreign trade; in 1913 the proportion had been 56 per cent. In the home group the percentage exported in 1938 was 7 per cent, and in 1913 it had been 13 per cent, but nearly half of the exports from the home group was of bunkers. There has thus been a marked difference between the two groups in relative dependence on the export trade and, with differential movements in export and home consumption during the last two decades, decline of output has been focused on the export fields. The 1937 output, as compared with that of 1913, was 75 per cent in the export group, but 91 per cent in the home group. This

[1] *Kent Coalfield, Regional Survey Report* (1945) attempts an explanation on the grounds of the friable nature of the coal, of the variations in seam thicknesses and of wage-rates. But these are not peculiar to the field.

is all the more striking when it is remembered that the home group includes several fields—Lanarkshire, Lancashire, and the Black Country—whose output is declining through depletion of reserves. If these fields be subtracted from the home group, the remainder had a slightly *higher* output in 1937 than in 1913. To this difference in relative dependence on exports is added a difference in the nature of the home trade. The home group supplies the large domestic and general industrial market of industrial Lancashire and West Yorkshire and of the industrial Midlands, areas which grew to full industrial stature well before 1850, and which have developed a dense population and a wide range of manufacturing industry. The export group, particularly South Wales, Cumberland, and the North-east Coast—for the Scottish export fields do not fit completely into the following generalization—has a more recent large-scale industrial growth with a less dense local population and a more specialized industrial character almost limited to iron and steel with its subsidiaries in the form of tinplates and shipbuilding. Iron and steel manufacture in these export fields, although in every case originally based on local iron ores, is now largely or partly dependent on imported ores brought as return cargoes in colliers engaged in coal export. Even their industry is bound up with foreign trade. During the inter-war period until rearmament began, the iron and steel industry was depressed with under-employment of plant and personnel. Depression in coal export thus coincided with depression in iron and steel manufacture. This has emphasized still further the decline in output of the export group. It has been emphasized still further again by the worsening position of these export fields in relative costs of production. All, even Northumberland, have costs above the national average.[1]

Dependence on export trade has had certain corollaries in respect of fluctuations in volume of production. The greatest seasonal variation of output was found in those fields producing household coal; they were active in winter but slack in summer. In contrast, the export fields exhibited seasonal variations of much smaller magnitude, for shipments are made independently of the season. Export trade is not devoid of marked fluctuations of volume accompanied by marked fluctuations of price, but these fluctuations are irregular and exhibit no seasonal rhythm. In other words, the fluctuations in the house-coal districts—and all the home fields have this characteristic to some extent—are regular and to some extent predictable, but in the export fields they are irregular and to a large extent unpredictable. Rowe has pointed out the effects of this difference on methods of wage regulation in the past in the two groups of fields.[2]

[1] The Reid Report (*Coal Mining: Report of the Technical Advisory Committee* (1945), Cmd. 6610) remarks on the worsening position of the export fields *vis-à-vis* the home market fields in output per man-shift.

[2] Rowe, op. cit., Chapter III.

IV

TRENDS IN DISTRIBUTION OF PITS WITHIN A COALFIELD

Changes in the relative importance of the coalfields of Britain, analysed above, have been accompanied by changes in the detailed geographical distribution of coal-mining *within* each coalfield. These changes have long been in progress as the older parts of the fields have gradually become exhausted—in an economic if not in a physical sense—and as the newer parts have gradually come into production. With the depression in coal-mining of the inter-war years and the consequential closing down of redundant pits, these changes have been particularly active, and the following discussion, based on the *List of Mines*, relates to trends particularly between 1911 and 1938.

The closing down of a colliery may be due to many causes, and it is necessary to glance at these in order to facilitate the discussion of changes in particular sample regions. A colliery may close down because it is inefficiently managed or unwisely or inadequately financed; it may close down because it is expensive to work owing to unfavourable physical conditions; or it may close down because its resources are exhausted and little coal capable of being won is left in the pit. The second and third conditions are related to physical factors, but the first condition displays no correlation with physical circumstances. Not all high-cost producers under the second condition necessarily close down, for coal is an expensive commodity to transport and high-cost producers supplying a local market may be able to supply as cheaply as a distant low-cost producer whose coals have to bear transport charges in addition. The average cost of coal transport by rail in Great Britain in the inter-war period was approximately 1*d.* per ton-mile,[1] which, other things being equal, would allow a high-cost producer, whose costs are 24*s.* per ton, to continue to supply a local market if its competitor, whose costs are 16*s.* per ton, is situated more than 100 miles away. This is a hypothetical case, but, to take an actual example, it is still possible for the high-cost Lancashire coalfield to continue to supply the Lancashire market even though the low-cost Yorkshire coalfield sends coal into Lancashire in large quantities.[2] But the protection of distance does not apply to the same extent to different pits *within* a coalfield, and high-cost pits are closed down more readily if lower-cost pits are available near by to supply the market. This is facilitated if high-cost and low-cost pits are owned

[1] It was 1·3*d.* per ton-mile in 1942–4, and 1·6*d.* in 1949.

[2] In 1938 Lancashire (together with North Stafford) had total costs of 18*s.* 2*d.* per ton and Yorkshire of 15*s.* 7*d.* per ton, a difference of 2*s.* 7*d.* The approximate distance by rail between Wakefield and Rochdale is 39 miles and between Sheffield and Manchester 44 miles. Probably most of the Yorkshire pits sending coal into Lancashire lie east of Wakefield and Sheffield, and therefore at greater distances from the Lancashire market.

by the same undertaking, which can therefore concentrate its output on the most efficient collieries. The third condition, that is, of exhaustion, is rarely satisfied in any complete sense, for a pit may close down long before physical exhaustion arrives, at a stage when only unremunerative seams remain and when costs of working are in consequence rising rapidly. A stage of economic exhaustion thus precedes physical exhaustion and it is usually the former rather than the latter which is significant.

The sample fields chosen for detailed analysis of internal changes in distribution of pits within the last quarter of a century are the Lancashire and the Yorkshire–Derby–Nottingham fields, the one with a declining, the other with an increasing, output. Both are concerned primarily with the home trade and have been affected to only a limited extent by fall in export. (See Figs. 37–42.)[1]

In the Lancashire coalfield, as in all others, it was the outcrop parts of the field that were first worked. These outcrops were the original, and are still the main, sites of steam industrialism in Lancashire. They were intensely worked for manufacturing and house coal, and, although shafts were sunk deeper and coal won from poorer seams, the demand was so great that almost all of the available coal was won and colliery after colliery closed down. Residual areas of coal have often been reworked by small shallow workings employing under fifty men underground, but workings of this size are almost invariably ephemeral.[2] Adit workings, along outcrops of the Mountain Mines of the Lower Coal Measures particularly, are frequently opened up by unemployed colliers in times of severe trade depression, but they are abandoned as soon as the pits can reabsorb their personnel.

In the Burnley Basin the number of men employed has contracted in approximately the same proportions as in the Lancashire field as a whole. There has been a certain amount of redistribution of production, for, although some pits have closed down and others have decreased their scale of activity, a few employed more men underground in 1938 than they had done in 1911. This redistribution has been facilitated by the circumstance that a few firms control nearly all the workings. There has been a substantial shift in this part of the field in the relative balance of output as between Lower and Middle Coal Measures. Even in 1911 the pits working seams in the Middle Coal Measures employed a smaller aggregate of men underground than the pits working seams in the Lower Coal Measures, and there has subsequently been a greater decline in numbers employed by the former than the latter. In 1938 about three-quarters of all the men employed underground in the Burnley

[1] Maps for Lancashire for 1913, 1929 and 1936, with certain refinements, had previously been drawn by Miss H. M. Lyon.

[2] Of seventy-three workings employing less than fifty men underground in 1911 and 1938, only ten were working in both years.

Basin were engaged in working the Mountain Mines of the Lower Coal Measures. One pit in the interval had abandoned its workings in the Middle Coal Measures and had come to win coal from the Mountain Mines alone. Those pits with increased employment also were limited to those working the Mountain Mines, which yield a good coking coal. The pits of the Burnley field have a lower output per man-shift than those of South Lancashire.[1]

The South Lancashire field is broken up into several sectors by the north-west–south-east faulted systems of the Irwell Valley and of the Wigan district. In order to elucidate trends in distribution it will be best to begin with that relatively undisturbed sector lying between the Irwell and the Wigan faulted systems, and where the outcrops run east–west. Three zones may here be distinguished—a northernmost against the foot of Rossendale and on the site of textile towns such as Bolton; an intermediate zone out in the plain and comprising coal-mining villages such as Atherton and Tyldesley; and the southernmost zone on the very edge of the industrial area and comprising Worsley and Astley. The first and second zones lie in the exposed field, but the third marks the contact between the exposed and the concealed fields. Coal-mining has shifted gradually southwards. Between 1911 and 1938 approximately 86 per cent of the pits in the northernmost zone, 75 per cent in the intermediate zone, but only 37 per cent in the southernmost zone had either closed down or decreased their underground personnel.[2] Expressed in another way, the underground personnel had decreased by 82 per cent in the northernmost zone and by 35 per cent in the intermediate zone, while in the southernmost zone it had increased by 50 per cent. These figures are eloquent of southward migration towards the concealed field.

The Irwell Valley, on the eastern fringes of the sector just considered, exhibits the same southward migration. Thus at Kearsley mining ceased, at Clifton employment underground declined by 65 per cent, and at Pendlebury and Pendleton by 55 per cent. The Irwell Valley, however, is closely settled and the decline was general. On the extreme eastern flank of the South Lancashire coalfield in the neighbourhood of Oldham and Ashton-under-Lyne no collieries on the hill slopes still remain, but a few continued to work in 1938 at the foot of the hills where the Coal Measures are faulted down to great depths.[3] But, including the Bradford colliery, these pits employed underground in 1938 less than 40 per cent of the number employed in 1911.[4] Both in the Irwell Valley tract and in the

[1] *North-western Coalfields, Regional Survey Report* (1945), Ministry of Fuel and Power, p. 27.

[2] In the southernmost zone the pits which had closed down were old collieries like the Duke of Bridgewater's at Worsley.

[3] The seam most commonly worked is the Roger.

[4] Of eleven collieries working in 1911, only four remained in 1938.

Manchester embayment decline has been greater than in the Lancashire coalfield as a whole.

In the faulted trough running from Wigan southwards through Ashton-in-Makerfield to Earlstown and Lowton the same southward shift of emphasis is recognizable. In the Wigan, Hindley, and Pemberton district numbers employed underground declined between 1911 and 1938 by 63 per cent, but farther south, in Ashton-in-Makerfield, by 47 per cent, and still farther south, in Haydock, Earlstown, and Lowton, at the transition from the exposed to the concealed field, by only 9 per cent. It is the more northerly districts, which have been longest worked, whose numbers have declined most. In the northern area only 12 per cent of the collieries exhibited any increase in number of men employed, and these all belonged to the Wigan Coal Corporation (part of the Lancashire Associated Collieries until nationalization), a large combine which had been able to redistribute its production on its, presumably, more efficient pits. In the middle area 25 per cent of the collieries displayed an increase in employment underground and in the southern area 47 per cent.

In the westernmost sector of the South Lancashire field, that lying west of the Wigan faults, and apart from the 'upland' pits working the Mountain and Arley Mines, there has been the same profound distinction between the collieries in the northern and in the southern parts of the field. In the Rainford, Bickerstaffe, and Skelmersdale districts north of St. Helens all pits have closed down, although a single 'day eye'[1] has been opened up. In the St. Helens district proper the number employed underground declined, as between 1911 and 1938, by 73 per cent, but in the Cronton and Sutton district south of it, and on the edge of the concealed field, numbers employed underground have increased by 63 per cent.

A marked southward migration of the main centres of coal-mining activity in the South Lancashire coalfield may thus be established. In the north-west–south-east faulted troughs decline has been general, though the southernmost pits have declined least. In the sectors east and west of the Wigan faulted tract there has been an actual increase in numbers employed underground along the southern margins of the field, and it is in these sectors that the new collieries are focused. The greater part of the mining activity of the South Lancashire coalfield is now confined to a narrow belt about three to four miles wide, marking the southern limits of the exposed field and stepping over into the concealed field. Apart from the Wigan faulted trough, the rest of the South Lancashire field has hardly any pits away from this narrow belt. Migration of colliery workers, however, has not kept pace with these shifts in distribution of employment and there is a daily migration to the southern collieries from towns and

[1] The expressive local name for an adit.

villages farther north developed in association with earlier pits now closed down.[1] The daily migration is only a short-distance one (it is only five miles from Wigan to Ashton-in-Makerfield), and it would be economically wasteful to build new pit-head villages of sufficient size to accommodate the whole of the working personnel so long as housing and the attendant public services are already in existence within reasonable travelling distance. Owing to the provision of pit-head baths it is no longer so essential for the colliery worker to live within a few minutes' walk of the pit-head. A colliery is a wasting asset and cannot expect to have as long a life as a textile mill or an engineering works. A further southward migration of coal-mining in South Lancashire is to be expected, but only within relatively narrow limits. The field is badly faulted and the Coal Measures pitch steeply southwards to great depths below the surface. There is also a further deterrent. The country to the south of the present line of pits is low-lying and subsidence consequential on the removal of coal would depress that part of it which now lies below 50 feet to below sea-level.[2] This would mean the loss of valuable agricultural land, whose productive economic life is of an infinitely greater span, though of much lesser intensity, than that of a colliery.

The Yorkshire–Derby–Nottingham coalfield equally exhibits shifts in the geographical distribution of collieries and of men employed. As in the Lancashire field it was the outcrop parts that were first worked, particularly the seams of the Lower Coal Measures which crop out on the lower Pennine slopes and can be worked by adits driven in from the valley sides. The same area had been the site of industry long before the Industrial Revolution created a large-scale demand for coal. The hill outcrops have thus been intensively worked and the greater part of the available coal has already been won. The Middle Coal Measures do not come in until the foothills are reached. The outcrop of the Silkstone seam, the base of the Middle Coal Measures, runs west of Dewsbury, through the village of Silkstone west of Barnsley, through Sheffield and along the hill slopes west of Chesterfield, throughout at an altitude of 400–500 feet. The exposed part of the Middle Coal Measures thus lies between the Pennines and the outcrop of the Magnesian Limestone. The Middle Coal Measures pitch eastwards under the Magnesian Limestone and the concealed field is worked by shafts driven through the cover of the Magnesian Limestone, and, still farther east, of the

[1] From Wigan, Ince, and Hindley into Abram, Ashton-in-Makerfield, and Leigh, to give a specific example, daily migration was of the order of 8,600, according to the returns of the Workplaces Tables of the 1921 Census of England and Wales. Not all of these, of course, would be colliery workers. It is unfortunately not possible to give similar data for a later census year. Workplace Tables were not constructed for the reports on the 1931 Census.

[2] See report on coal-mining in *Future Development of South-west Lancashire* (1930), the Report of the South-west Lancashire Joint Town Planning Advisory Committee, pp. 33–9. See also *Merseyside Plan, 1944* (1945).

Trias as well. Pits thus sunk through great thicknesses of super-incumbent strata have operated on a large scale from the first. For purposes of analysis it will be convenient to consider the field in its separate parts—West Yorkshire, South Yorkshire, Derby, and Nottingham.

The hilly tracts of the West Yorkshire field may be divided into two parts—that within the textile district and that, south of the Calder, outside it. The two parts have exhibited rather different trends, though the size of colliery is similar in both, being of small or medium dimensions. In the textile district there are very few collieries employing more than fifty men underground on the western edge of the field, though some coal is worked in conjunction with fireclay for their own purposes by the long line of brick, pot, and tile works of the scarp edge of the Lower Coal Measures overlooking the Millstone Grit. In the textile district there has been a marked thinning out of pits since 1911, the decline of underground personnel by 1938 being as much as 63 per cent. Those remaining are chiefly in the eastern part, in the heavy woollen district and east of it. In the non-textile district south of the River Calder thinning out has been less pronounced and a more marked cluster of pits remains to-day. The decline in underground personnel has been much less, amounting to only 24 per cent. The Beeston seam near the top of the Lower Coal Measures is the most important, but this is absent from the western part of the Lower Coal Measures, and here the Halifax Hard provides the bulk of the output.

The sector in the Vale of York presents different characteristics. There are but few pits in the concealed field, and they overstep the Magnesian Limestone outcrop by only a few miles. In the first place, the collieries are much larger in size than those of the hilly tract to the west, having on the average an underground personnel of 999 men in 1911 and of 1,069 in 1938. Being larger, the pits are spaced rather more widely apart. Unlike the hilly tracts, where mines remained relatively steady in size, some pits here increased the numbers employed underground. In the second place, the number of men employed underground declined between 1911 and 1938 by only 11 per cent, which is substantially less than farther west. The decreased employment was distributed in relatively small parcels among a large number of collieries, there being few which had closed down altogether. Some collieries exhibited increased employment, and these were in the eastern part, chiefly along the banks of the River Aire. The Barnsley Bed is worked only in the extreme south-east part of the West Yorkshire field,[1] but even here it is split up by dirt partings, and in only one instance is it the only seam worked. West Yorkshire collieries are hence dependent on other seams, particularly on the Silkstone, at the base of the Middle Coal Measures, and on the

[1] Upton, Hemsworth, Normanton, Featherstone, and Glass Houghton.

Haigh Moor, higher in the series but below the Barnsley. Many collieries have sunk their shafts deeper still, into the Lower Coal Measures, and are winning coal from the Beeston, at the top of the Lower Coal Measures. Indeed, several pits are now wholly dependent on the Beeston seam, including two in the concealed field, and the proportion of the total output contributed by the Beeston increased from 10 per cent in 1894 to 20 per cent in 1911 and 34 per cent in 1929.[1] The West Yorkshire field relies more on the lower seams in the Coal Measure series than does the South Yorkshire field; structure and erosion are partly responsible, as this is the northern margin of the coal basin, but it may also be inferred from the above evidence that its resources have been depleted to a greater degree.

The South Yorkshire field displays many differences from the West Yorkshire field. The Lower Coal Measures contribute to a very much smaller extent to the total output and the Middle Coal Measures, especially the Barnsley Bed, with seams lying above it, contribute to a very much larger extent. These differences are due partly to the lesser development of coal at the horizon of the Beeston and to the better development of the Barnsley Bed and of seams lying above it. But they also bear witness to the less extensive depletion of the resources of the South Yorkshire field. The West Yorkshire field had the greater output throughout the nineteenth century, though to-day South Yorkshire mines over twice as much.[2]

The migration of mining towards the concealed field is displayed neatly in the northern part of the South Yorkshire field north of the Don Valley faults. This may be divided into three belts, all in the Middle Coal Measures. The westernmost lies to the south-west of the Dearne Valley, which contains Barnsley at its northern end and itself trends north-west–south-east; the second lies on the floor of the Dearne Valley and to the north-east of it; the third lies farther east on the margins of the concealed field. The first belt exhibited a decline of 20 per cent in numbers employed underground between 1911 and 1938. The seams worked here all lie in the lower series of the Middle Coal Measures from the Parkgate downwards, and this was as true of 1911 as of 1938. The second belt exhibited a decline of 9 per cent, a substantially lesser amount. In this second belt the seams worked are distributed more widely over the whole series of the Middle Coal Measures, including the Barnsley and seams above it as well as seams in the lower series. But significant changes were taking place between 1911 and 1938. At the earlier date the Barnsley was the most important single seam, but in 1938 it was the Parkgate, much lower in the series. Other seams below the Barnsley, such as the Haigh Moor and the Silkstone, also

[1] *The Upper Beeston Seam*, Physical and Chemical Survey of the National Coal Resources, no. 35 (1935), p. 2.

[2] For maps of collieries in Yorkshire in 1855 and 1895, see G. D. B. Gray, 'The South-Yorkshire Coalfield', *Geography*, vol. XXXII (1947).

increased in relative importance. Working of additional seams lower in the series had occurred in this group at six out of the nine collieries which exhibited an increase in employment. In the third belt there was not a decline, but an increase in number of men employed underground to the extent of 38 per cent. There is a similarly wide range of seams worked as in the second belt, but it includes the Shafton at the top of the Middle Coal Measures and excludes the Silkstone at its base.[1] The Barnsley was the most important seam in 1938, as well as in 1911, though at the later date a greater number of seams were being worked than previously, particularly seams in the lower series. It is clear, therefore, that mining is shifting towards the concealed field, that the lower seams, the Silkstone and Parkgate, become progressively less important and the Barnsley becomes progressively more important eastwards, but that the sinking of shafts to deeper and deeper seams is general. There are also differences in size of colliery as between the three belts, employing an average of 510, 986, and 1,706 men underground respectively in 1938. In the second and third belts there was an increase in size subsequent to 1911, but a small decrease in the first belt. The West Yorkshire field presents several analogous trends.

A traverse of the field down the Don Valley from Sheffield and Rotherham to the confines of Doncaster affords another example of the same shift. A group of collieries between Sheffield and Rotherham exhibited a decline between 1911 and 1938 in underground personnel of 48 per cent, a decline involving all pits. In 1911 two of these pits had worked the Barnsley Bed, but by 1938 they had ceased to do so and the Haigh Moor was the highest in the series still mined, though the Parkgate and Silkstone probably contributed most to the total output. A second group farther east, about Kilnhurst, presented a smaller decline of 32 per cent. Here the Barnsley Bed had been the only seam worked in 1911, but this was no longer true in 1938. In the third group, on the extreme eastern edge of the exposed field, there had been an increase of 43 per cent in the number employed underground. In 1911, as in the second group, the Barnsley had been the only seam worked, but by 1938, except in the case of one colliery only newly opened up in 1911, the Parkgate had been added to the Barnsley. In this traverse, as in the other, the same shift towards the concealed field and the same tendency to win coal from seams deeper in the series is evident.

At the southern end of the exposed field, in Derby and Nottingham, there is no evidence of such a shift towards the concealed field. In the Derbyshire part the number employed underground declined between 1911 and 1938 by 30 per cent, but in the Nottingham part, farther east and nearer the concealed field, the decline had been by

[1] This was in 1938. In the second belt the Silkstone was worked but not the Shafton.

41 per cent. The southern end of the exposed Yorkshire–Derby–Nottingham field is structurally different from the rest of the field by reason of the Erewash and Brimington anticlines which bring the Lower Coal Measures to the surface or near to the surface and limit the outcrop of the Barnsley Bed to only a narrow strip in the exposed field.

In the Yorkshire–Derby–Nottingham field mining has penetrated far into the concealed field, and this is contributing more and more substantially to the total output. In 1911 the pits in the concealed field had 19 per cent of the total number employed underground, but in 1938 34 per cent. While in the field as a whole the number employed underground decreased between 1911 and 1938 by 4 per cent,[1] it decreased by 22 per cent in the exposed field and increased by 71 per cent in the concealed field. Some parts of the exposed field exhibited increases, but they were those in proximity to the concealed field. The concealed field, however, is itself diverse in character: the pits close to the boundary of the concealed field and the pits far removed from it have exhibited different trends. The collieries lying close to the boundary of the exposed field had decreased their numbers employed underground by 30 per cent, but those farther out in the concealed field had increased by 137 per cent. Of the twenty-two pits of the concealed field which exhibited a decrease fourteen lay close to the edge of the exposed Coal Measures and most of these were at the extreme northern and southern ends, that is, near the margins of the coal basin. Throughout the concealed field, however, the Barnsley is the most important and often the only seam worked. In 1911 twenty-eight pits out of thirty-one worked the Barnsley Bed and twenty-four of these won coal from no other seam. In 1938 the numbers were thirty-six out of forty-nine, of which twenty-three worked no seam other than the Barnsley. The Barnsley Bed is the most important of all in those pits far removed from the exposed field; in these only three pits out of twenty-nine won coal from seams lower down in the series, but in the pits close to the exposed field eight pits out of nineteen won coal from seams lower than the Barnsley Bed. Thus, though less important near to the boundary, the Barnsley dominates the concealed field throughout its whole extent.

In the Lancashire field, long exploited and with a declining output, the working pits have come to be concentrated in a narrow belt lying astride the zone where the exposed field passes into the concealed field. In the Yorkshire–Derby–Nottingham field, only parts of which have been as long and as intensively worked as the Lancashire field, and which has an increasing output, pits are more widely scattered over a broader zone. The difference is by no means entirely, however, a function of obsolescence, for the more gently

[1] Output had increased, however.

pitching Yorkshire–Derby–Nottingham field permits a broader zone of operations than the steeply pitching Lancashire field, which quickly falls to too great depths for mining under the Permo-Trias of the Cheshire cuvette. Thus structure as well as obsolescence contributes to the difference. A third factor has not been without significance. The greater progress of organic amalgamation in the Lancashire field has facilitated the closing down of relatively obsolescent pits and the concentration of production on what are, presumably, the more efficient pits in the narrow zone overstepping the concealed and exposed fields. The greater scatter of pits over a wide area in the Yorkshire–Derby–Nottingham field and an expansion of production far into the concealed field have necessitated not only a daily but also a permanent migration of workers. It is too far to travel daily from the villages built around the declining pits in the western part of the exposed field to the new and growing pits in the concealed field. New pit-head villages have had perforce to be constructed in the midst of the otherwise rural Vale of York and the Forest Sands of Nottingham.

CHAPTER VII

IRON AND STEEL MANUFACTURE

I

RESOURCES OF ORE AND COKE

THE location of an iron and steel industry, using relatively low-grade materials in bulk, is modelled largely on the provenance of its raw materials. As will appear later, not every branch of the industry is moulded to the same degree, the initial stages of manufacture being influenced more profoundly than the latter.[1] The preliminary to a geographical analysis of the industry is a survey of the iron ore and coke resources of Britain, these being the bulkiest of the materials employed. There is space for only the barest summary.

TABLE XXXV

Analysis of Jurassic Ironstones

	Iron	Lime	Phosphorus
Cleveland ironstone . . .	27·9	4·9	0·46
Frodingham ironstone . .	23·1	18 6	0·30
South Lincs, Leicester, and Oxford ironstone	25·2	9 6	0·25
Northampton ironstone . .	32 1	2·8	0 58

Calculated from average analyses for 1917–18, prepared by F. H. Hatch and published as Appendix I to his *Iron and Steel Industry* (1919). The percentages are of ore in natural condition as received at the furnace.

British iron ores of workable deposits comprise (*a*) metasomatic replacements in limestone in Furness, West Cumberland, and the southern margin of the South Wales coalfield; (*b*) bedded ores in the Coal Measures; (*c*) bedded ores in the Jurassic and Cretaceous. The first group is the richer in iron with 50 per cent or over Fe, the second group has 30–35 per cent Fe for clay ironstones and up to 38 per cent Fe for black-band ores; the third group ranges from 23 to 32 per cent Fe, as Table XXXV shows. The reserves, as calculated by the Geological Survey's Special Reports on the Mineral Resources of Great Britain some twenty-five years ago, were 35–40 million tons for West Cumberland haematite, 5 million tons for

[1] Blast furnaces display a very large loss of weight in the process of manufacture. In 1937 the materials consumed were four times the weight of the finished product. Alfred Weber declared in 1909 that, in the words of Friedrich's translation, 'Weight-losing materials . . . may pull production to their deposits.' Blast-furnace work provides an admirable illustration (A. Weber, *Über den Standort der Industrien* (1909), trans. and ed. by C. J. Friedrich (1929), p. 61).

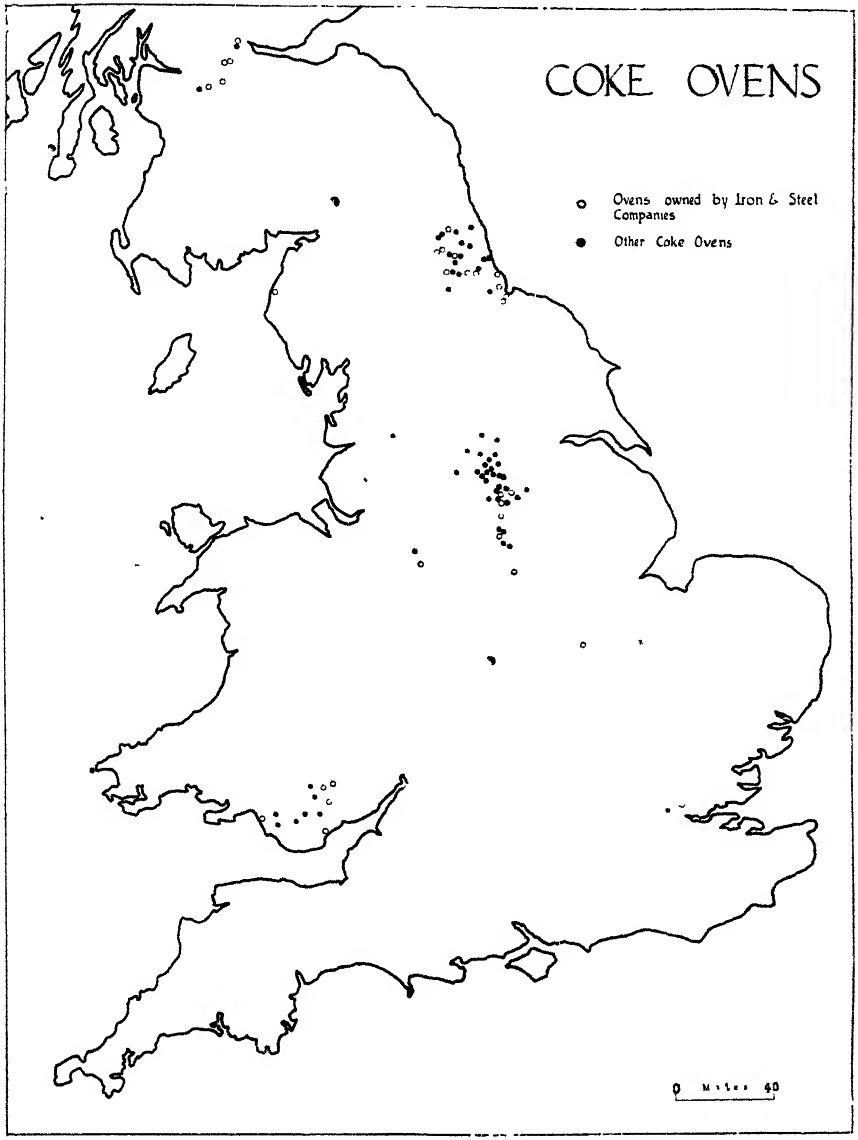


Fig. 44

COKE OVENS IN GREAT BRITAIN

By permission of the Ordnance Survey.

Furness haematite, and perhaps a similar amount for South Wales haematite. The total reserves of Coal Measure ores have been estimated at 7,230 million tons for England and Wales alone. The reserves of the Jurassic orefields have been placed at 440 million tons for Cleveland, 320 for Oxford (Banbury), 1,715 for Northampton, 374 for North Lincoln (Frodingham), and over 500 for South Lincoln. The coking coals of Britain, as defined by chemical analysis, are set out in Table XXXVI, and the quantities of coke actually produced in Table XXXVII. They present in tabular form the barest summary of the coke resources of the country.

TABLE XXXVI

Analysis of Coal and Quality of Coke

Seam and District	Carbon	Hydrogen	Volatile Matter	Swelling Power	Shatter Index
Two-Foot-Nine (S. Wales)	89·7	4·65	21·9	145	97
Victoria (Durham)	89·7	4·82	24·6	134	95
Busty (Durham)	88 7	4·93	25·6	199	93
Parkgate (S. Yorks)	86·9	5·40	36·7	129	89
Halifax Soft (W. Yorks)	86·8	5·35	33·0	136	92
Mountain Mine (Lancs)	86·6	5·39	30·3	86	92
Silkstone (S. Yorks)	86·5	5·45	35·1	100	86
Barnsley (S. Yorks)	85·1	5·17	34·5	65	79
Winter (W. Yorks)	83·9	5·12	33·7	8	70
Waterloo (Derby)	83·0	5·35	36·2	—	72

Extracted from R. A. Mott and R. V. Wheeler, *The Quality of Coke* (1939), Table LXXIII. The swelling power is a percentage of the dimensions of the raw coal, and is that as measured by the Sheffield Laboratory Coking Test. The shatter index is a measure of the liability of the coke to break, the higher the figure the less is the liability to shatter.

II

REGIONAL ANALYSIS OF IRON SMELTING

Let us now proceed to consider the character of pig-iron production and the location of blast furnaces. Location cannot be understood apart from the technique of production.

The object of smelting in the blast furnace is the chemical reduction of the iron oxides, in which form iron frequently occurs in nature or into which ores are converted prior to smelting, by driving off the oxygen, and the essential agent in this reduction is coke. On combustion coke serves a double purpose: it raises the temperature of the ore and of the limestone lying above it in the furnace to such levels as are necessary for chemical reaction, and, secondly, it combines with the oxygen of the blast to form the gas carbon monoxide. By several successive stages the carbon monoxide

TABLE XXXVII

Coke Production by Districts

A. As percentage of Total Coke Output

	North-east Coast	Yorks and E. Midlands	W. Midlands	S. Wales	Lancs and N. Wales	Cumberland	Scotland	Total
1929 . . .	40·0	33·6	2·7	12·5	3·9	3·4	3·9	100
1932 . . .	33·1	43·6	2·8	10·6	3·9	2 8	3·3	100
1937 . . .	36·9	37·7	2·4	12·3	3·4	2 8	4·5	100

B. Coke and Breeze per ton of Coal Carbonized

	North-east Coast	Yorks and E. Midlands	W. Midlands	S. Wales	Lancs and N. Wales	Cumberland	Scotland	Total
1929. Coke . .	0·69	0 66	0·61	0 67	0·64	0·68	0·69	0·67
Breeze .	0 03	0 03	0·03	0 04	0·03	0·02	0·03	0·03
1932. Coke . .	0·69	0 65	0·57	0·70	0·70	0·68	0·68	0·67
Breeze .	0·04	0 05	0·08	0 04	0·05	0·02	0·03	0·04
1937. Coke . .	0·71	0·63	0·64	0·74	0·77	0·71	0·69	0·68
Breeze .	0·03	0·08	0·14	0·05	0·02	0·03	0·04	0·05

Calculated from the *Reports* of the Secretary for Mines and of H M. Inspectors of Mines.

C. In 1949. As percentages of total for Great Britain

	Durham, N. Riding	W. & E. Ridings	Derby and Notts	Lincs, Essex, Northants.	Stafford	Lancs and Cumber-land	Scotland	Wales	Total
Coke production . .	32·9	23·0	8·5	11·3	3·1	5·1	5·5	10 6	100·0
Disposal of coke:									
Furnaces . . .	29·9	20·9	6·0	16·7	3·2	5·7	6·2	11·4	100·0
Others . . .	39·3	26·3	12·5	1·2	3·0	3·8	4·4	9·5	100·0
Disposal of coke-oven gas:									
Coke-oven plant .	36·9	28·5	9·8	5 6	3·5	5 8	4·0	5·9	100·0
Steel works . .	25·7	6·0	1·8	36·3	1·2	6·0	6·9	16·1	100·0
Gas undertakings. .	24·2	33·3	11·0	2·2	6·2	3·1	6·1	13·9	100·0
Others . . .	60·4	18·5	14·4	4·1	—	1·8	—	0·8	100·0

Calculated from *Statistical Digest*, Ministry of Fuel and Power.

reduces the iron oxides, setting free the iron and producing the gas carbon dioxide. Both iron ore and coke, particularly the former, contain impurities, and it is necessary that these should be separated from the iron. The addition of limestone into the furnace serves this purpose, the lime fluxing with the impurities and forming molten slag which can be run off separately. The proportions of ore, coke and limestone fed into the furnace are not fixed and vary within wide limits. If the ore has a high iron content, the amounts of coke and of limestone required are reduced; if the ore is calcareous, limestone may be dispensed with altogether. The pig iron thus produced contains 92 per cent Fe or thereabouts, is impregnated with carbon, and may contain some other elements as well.[1]

The output of pig iron in Great Britain, though subject to marked short-term fluctuations of the magnitude of 10–20 per cent, continued to increase until 1906–13 (see Fig. 16). It subsequently declined, to very low levels indeed, during the Great Depression. Output at the crest of a trade-cycle was 10¼ million tons in 1913, 7½ in 1929, and 8½ in 1937, the difference between 1929 and 1937 being due to rearmament. The reasons for this lower level of output are complex and will be discussed more satisfactorily later in the general setting of the iron and steel industry as a whole. Although output was increasing up to 1906–13, it represented a declining share of world output. Even so late as 1875 the United Kingdom was producing 46·8 per cent of the pig iron of the entire world, apart from unrecorded small-scale production, but by 1912 its percentage had fallen to 12·1 per cent. The reorganization of production during the 'thirties and the building of new blast furnace plant have improved the competitive position of the industry and its world position has been stabilized. The annual average for the last quinquennial periods has been 7½ million tons in 1935–9, 7½ in 1940–4 and 8¼ in 1945–9. It has grown annually since 1945 and it reached 9½ million tons in 1949.

Pig iron, however, is a composite description, and it is instructive to break it up into its several constituents. Different pig irons are made from ores of different composition and each is designed for rather different subsequent use. The greater part of the haematite pig and practically the whole of the basic pig passes into the steel furnaces, but the forge and foundry pig are made into iron articles in the forges and foundries. Haematite pig is made from non-phosphoric ores having under 0·1 per cent of phosphoric acid: the rest are made from phosphoric ores having about 1·0 per cent of phosphoric acid.[2] The proportion that forge and foundry pig bears to the total has declined; this change registers the decline of iron and the increasing employment of steel. The proportion that haematite pig bears to

[1] This paragraph is based on W. A. Bone and G. A. Himus, *Coal: Its Constitution and Uses* (1936).

[2] This is a purely generalized figure. Frodingham ironstone has approximately 0·8 per cent, Cleveland 1·0 to 1·3 per cent, Northampton 1·9 per cent.

the total has also fallen, but the proportion of basic pig has risen: the change has been parallel with, and indeed called forth by, the decline of acid steel and the growth of basic steel. Discussion of the change will accordingly be deferred until later in the chapter. The demand for forge and foundry pig, though restricted, was steady in actual quantities during the inter-war period, the 1937 output of forge and foundry pig being almost identical with that of 1929. Within this period foundry pig exhibited a much smaller amplitude of fluctuation as between boom and depression than either haematite or basic pig. Since 1937, however, production has fallen from 1·8 million tons in 1937 to 1·0 in 1945.

TABLE XXXVIII

Production of Iron Ore and Pig Iron in Districts, 1855–1913

	1855	1870	1884	1913
Iron Ore				
South Wales and Forest of Dean	16·0	3·8	0·5	0·4
West Midlands	31·2	11 8	12·7	5·5
East Midlands	0 8	6·8	15·8	38·9
Yorks, Derby, Notts	6 4	4·3	1·0	—
North-west	9 5	23 6	25·9	17·5
North-east	11·1	26 4	33·2	34·3
Scotland	25·0	23·3	10·9	3·4
	100 0	100·0	100·0	100 0
Total ore output in million tons	9·4	13·9	15·6	16·0
Ore import, million tons	—	0·2	3·2	7·2
Pig Iron				
South Wales and Forest of Dean	27 2	17·4	11·6	8·7
West Midlands	30 6	17·1	8·2	8·3
East Midlands	—	1 3	5·9	20·7
Yorks, Derby, Notts	6·5	4·4	8·0	
North-west	0·5	11·5	20·5	11·3
North-east	9·3	27·7	32·8	37·7
Scotland	25·9	20·6	13·0	13·3
	100·0	100·0	100·0	100 0
Total make of pig iron in million tons	3·2	6·0	7·8	10·3
Average make weekly of furnaces in blast in tons	108	173	261	586

Calculated from Lowthian Bell, *Second Report*, Royal Commission on Depression of Trade and Industry (1886), pp. 320–2, and from *Statistics of the Iron and Steel Industries* (1935), pp. 7–8 and 22–3. Ore converted to pig iron equivalents before being reduced to percentages.

It is thus clear that pig-iron production in Great Britain has changed both in volume and in kind. Let us now consider its location within the country and the extent to which changes in location have developed. Regional data are set out in Table XXXIX for the years 1913, 1929, and 1937, representing the crests of trade-cycles, for the

year 1932, representing the trough of the Great Depression, and for 1949. Let us consider some of the more general points first. The districts may be grouped into sets—those in the Jurassic belt, those on or marginal to the coalfields, and that on the haematite orefields of West Cumberland and Furness. The first set, comprising the North-east Coast, North Lincoln, and the East Midlands,[1] was responsible for 53·5 per cent of the pig-iron output in 1913, 57·7 per cent in 1929, 63·7 per cent in 1937, and 60·8 per cent in 1949. The second set, comprising Lancashire and Yorkshire (excluding Furness and Cleveland), Scotland, the West Midlands, and South Wales, made 35·2 per cent of the total in 1913, 32·3 per cent in 1929, 26·6 per cent in 1937, and 30·9 per cent in 1949. The third, the North-west Coast, was responsible for 11·3 per cent in 1913, 10·0 per cent in 1929, 9·7 per cent in 1937, and 8·3 per cent in 1949. The Jurassic belt thus gained in percentage up to 1937 at the expense of both coalfield and haematite groups.[2] To what extent are these changes due to shifts in the location of supplies of iron ore? The Jurassic belt contributed 40·9 per cent of the total iron ore consumed (production plus import and adjusted according to iron content) in Great Britain in 1913, 45·6 in 1929, 47·6 in 1937 and 44·8 in 1949: the Coal Measure ores contributed 5·7 per cent, 1·9 per cent, 0·8 per cent, and nothing respectively; the haematite ores of the North-west Coast 10·9 per cent, 10·7 per cent, 5·9 per cent and 2·8 per cent respectively. Imported ore was thus 42·5 per cent in 1913, 41·8 per cent in 1929, 45·7 per cent in 1937 and 52·4 per cent in 1949. The increasing pig-iron percentage of the Jurassic belt thus reflects the increasing percentage of ore mined in that belt, and the declining pig-iron percentage of the coalfield and the haematite groups reflects the declining percentage of the output of haematite and of Coal Measure ores. The increasing importance of the Jurassic belt is a long-term change, in progress ever since the middle of the nineteenth century. The progress of the shift is shown in Table XXXVIII. The discrepancy between pig-iron percentage and iron-ore percentage is most striking in the coalfield group: iron smelting on the coalfields is a relic industry in respect of the provenance of its ore. It developed during the first phase of coke-iron manufacture when almost the whole of the ore smelted was of Coal Measure ironstones, and it has persisted, though contributing a declining proportion of the total production, by importing ores from the Jurassic belt or from abroad. But, where coal is carbonized at the point of mining, where coke-oven gas is used to heat the coke ovens and for other industrial purposes, and where the waste heat from the blast furnaces is employed in steel-making and in rolling-mills, it may not be a relic industry at all. Thus, the

[1] The East Midlands includes Derby and Nottingham, which are on the coalfield and not in the Jurassic belt.

[2] It will be noticed that changes which were progressive up to 1937 have come to a halt.

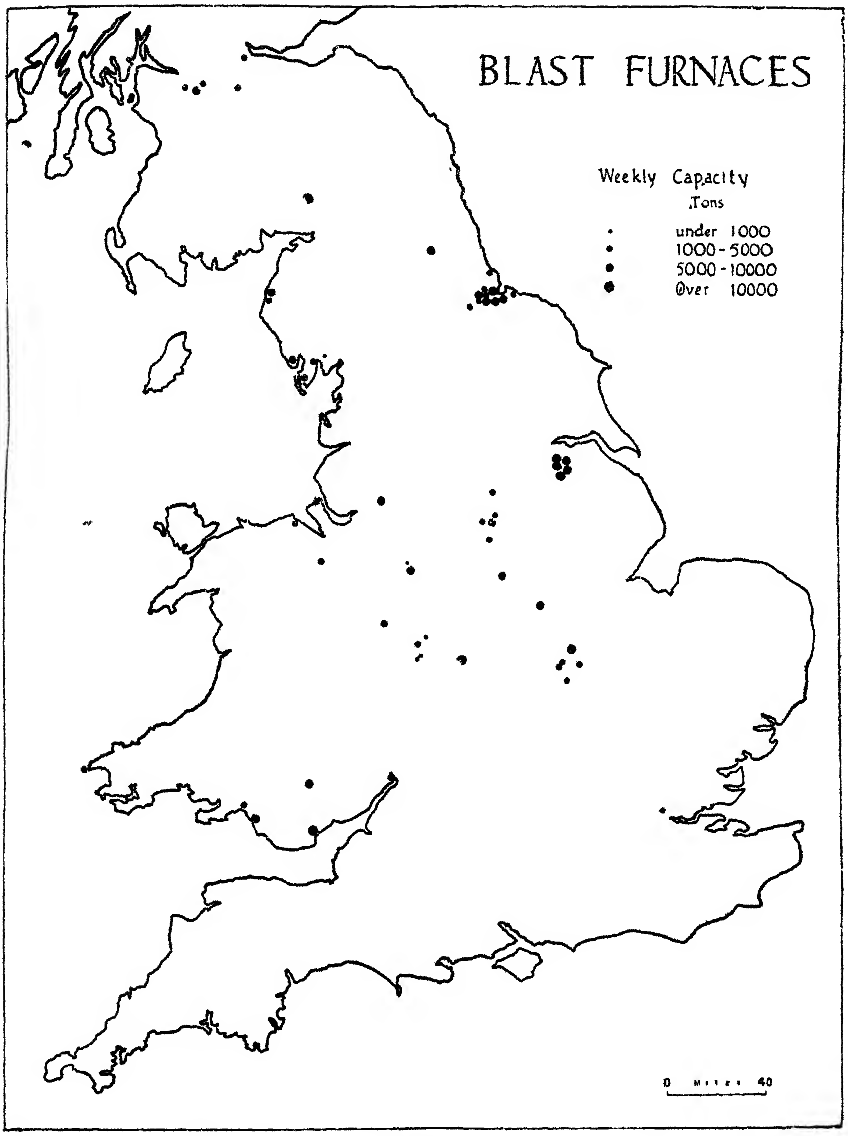


Fig. 45

BLAST FURNACES IN GREAT BRITAIN

By permission of the Ordnance Survey.

location problem of blast furnaces stated in terms of orefield *versus* coalfield is now, with present-day methods of by-product coke ovens and utilization of waste heat, incapable of being resolved except in reference to the iron and steel industry in its total sense.[1]

A second general classification of districts may be indicated at this stage. It will be noted from the index numbers and percentages of Table XXXIX that districts may be classified into two groups, according to whether their amplitude of fluctuation between trade-cycle crest and trough is less or greater than the average for the country as a whole. The East Midlands, North Lincoln, South Wales, and Lancashire–Yorkshire exhibit a degree of fluctuation less than the average: they had index numbers in 1932 above the national average and they had a higher percentage of total British output in 1932 than in 1929 or 1937. The North-east Coast and Scotland exhibit a fluctuation greater than the average: they had index numbers in 1932 below the national average. The North-west Coast and the West Midlands are not easy to place in this classification. This grouping is not a fortuitous one. The districts with the lesser amplitude of fluctuation (with the exception of South Wales) are inland districts, those with the larger amplitude of fluctuation are coastal districts. The first are concerned primarily with the home market, the second largely (directly or indirectly) with export overseas. In times of world trade depression international trade suffers greater restrictions than home trade, and those industries dependent on exports, whether of pig iron, of finished iron and steel, or of engineering products, suffer more severely than those serving the home trade. After this discussion of some of the more general points of Table XXXIX let us now consider each blast-furnace area separately, for they vary individually in geographical position, in function within the iron and steel industry as a whole, and in trend of production.

The North-east Coast, the fourth iron-smelting district in the middle of the nineteenth century, had become the first by 1870, even before the Gilchrist-Thomas process made its phosphoric ores available for steel-making. It has retained its pre-eminence ever

[1] Fully two-thirds of the blast-furnace firms (weighted according to their number of blast furnaces) directly owned in 1938 either coal-mines or ore-mines or both. Of the rest, some may have had associated companies engaged in mining coal or ore. These proportions have been worked out from the *List of Mines, 1938*. The Balfour Committee on Industry and Trade estimated in 1928 that British pig-iron manufacturers controlled 72 per cent of their ore supplies (home and abroad), 62 per cent of their coal, and 55 per cent of their coke (*Survey of Metal Industries*, p. 33). For 1900, D. L. Burn (*The Economic History of Steel Making* (1940)) estimated that three-quarters of British pig iron was made by firms owning either coal or ore or both. Ownership does not necessarily imply location on the same site. It does not necessarily imply integration of manufacture, but simply opportunities for the integration of management. Economic integration and geographical integration are not the same thing.

since. This pre-eminence was most marked about 1913, and its percentage of output has since fallen from 37·7 per cent in that year to 28·6 per cent in 1937, and to 23·4 per cent in 1945. It has been based on the close proximity of Durham coke[1] and Cleveland ore. There has been a great deal of vertical integration in the district—backward integration by blast-furnace owners acquiring coal-mines and ore-mines—and the assembly costs of materials were initially low. Blast furnaces were placed between coal and ore, though nearer to the ore for greater quantities of ore than of coke were required from the seventies of last century onwards.[2] Only the Consett blast furnaces occupy a different type of site. Consett is on the western margin of the coalfield and is thus a relic site of the early days of the coke-iron industry, but its plant was rebuilt in 1923 with coke ovens close by. It is presumably this comparative proximity to coking coal that keeps raw material assembly costs within reasonable proportions. Limestone is obtained from quarries in the Carboniferous Limestone of Weardale and in the Magnesian Limestone of East Durham.

The decline of the percentage of the North-east Coast has been due primarily to the increasing expense of working and to the increasing depletion of the Cleveland ironstone, which is becoming poorer as the outcrop is followed into the hillside. In 1937 the average net selling value[3] at mine or quarry was 7*s.* 2*d.* for Cleveland Middle Lias ironstones with 29 per cent iron, but 2*s.* 5*d.* for South Lincoln, Leicester, Northampton, and Oxford Middle Lias ironstone with 25 per cent iron, 2*s.* 8*d.* for Frodingham Lower Lias ironstone with 22 per cent iron, and 3*s.* 5*d.* for Northampton Inferior Oolite ironstone with 32 per cent iron. The gap in costs of working between Cleveland and the rest of the Jurassic ironstones is an increasing one. The district has been compelled to import ores either from other parts of the Jurassic belt or from abroad. The proportions used from these sources at different dates are set out in Table XL. The rail journey from the middle part of the Jurassic belt—the North-east Coast received no ore from North Lincoln—is a substantial one and renders the ore expensive in view of its relatively low iron content. It has been stated that 'at normal prices, the initial cost of native phosphoric iron ore would be doubled by a haul of about 35 miles and more than quadrupled by one of 120 miles'.[4] Two North-east Coast smelting firms themselves own and work Northampton ironstone in Northampton and Rutland. The richer foreign ore is employed in greater quantities, partly because of its richness and partly because it is essential for the production of haematite pig, of which the

[1] The amount of coke made is sufficient to meet the needs of the district and to allow export to the North-west Coast and abroad.

[2] By 1875 ore and coal required to make 1 ton of pig iron were 60 cwt. + and 49 cwt. respectively.

[3] Per ton.

[4] S. R. Dennison, *The Location of Industry and the Depressed Areas* (1939), p. 46.

North-east Coast and the North-west Coast are together the chief producers. The quantity of imported ore as a proportion of total ore consumed has been increasing steadily for a long time: it is now over two-thirds of that total. It may be that the quantity of home ore available to the North-east Coast is, in view of transport costs, relatively fixed and capable of only small increases and decreases, so that large increase of output has become dependent on imported ore, except under the special conditions of a war-time economy. The amount of home ore used other than Cleveland ironstone has varied little in percentage within recent decades at a time when import from abroad was growing rapidly. This dependence on imported ore, of course, tends to increase costs, though it implies some compensatory advantages.[1]

TABLE XL

Source of Iron Ore on the North-east Coast

	As percentage of ore used				
	1883	1913	1932	1937	1949
Cleveland ironstone	84	60	54	37	19
Other home ore	3½	6½	11	11	12
Imported ore	12½	33½	35	52	69
Total	100	100	100	100	100

Not only has the source of iron ore changed, but the relative importance of the several kinds of pig iron produced on the North-east Coast has changed also. The output of basic pig has increased, that of haematite pig remained steady until the war, that of foundry and of forge pig greatly declined. These trends indicate important changes. The increase in basic pig is common to every district. Although the largest single producer of basic pig iron, making over one-third of the British total in 1937 but 29·8 per cent in 1949, the percentage share of the North-east Coast has declined. Basic pig-iron production, in fact, is becoming more widely diffused in smelting districts. On the other hand, its percentage share of haematite pig increased during the 'thirties, haematite pig production having become concentrated increasingly into the two major districts of the North-east and of the North-west Coasts, the one being the largest importer and the other (apart from South Wales) the only home producer of high-grade non-phosphoric ores. Scotland has almost abandoned haematite pig production, but South Wales still retains a small output. The North-east Coast has abandoned

[1] The position of home *v.* imported ore is put as follows by the Iron and Steel Federation: home ore requires more capital equipment and more coal to make a given quantity of pig iron, and this has to be set against its lower cost (*Report of the British Iron and Steel Federation on the Iron and Steel Industry* (1946), Cmd. 6811). See also the Federation's *Statistical Bulletin*, vol. xxv, no. 11 (1950).

the greater part of its output of forge and of foundry pig. Both of these are becoming focused on the single district of the East Midlands, where they can be produced much more cheaply than elsewhere in Britain. Imported ores, on which the North-east Coast is coming increasingly to depend, are best suited for steel-making.

North Lincoln, one of the minor blast-furnace districts in 1913, and not separately distinguished in the statistical returns of the nineteenth century, is now the third district in order of pig-iron output. It was the only district which had an output in 1932 equal to that of 1913. Since 1932 its output has continued to grow at a faster rate than that of the country as a whole. Of the three firms with blast furnaces in North Lincolnshire, two have migrated from South Wales, that is, from an area of declining pig-iron production to one of increasing production. The ore is the leanest of all British ores, though it has the compensatory advantages of being cheap and easy to work by open-cast methods and of being calcareous and, therefore, self-fluxing. Although the field has a substantial reserve, its limits are relatively circumscribed. Moreover, underground mining will become increasingly necessary in the future, as at depths of over 40 feet the Scunthorpe quarries become flooded.[1] A certain amount of siliceous Northampton ore is added in the charge in order to correct the excess lime of the local ore, and small quantities of imported ore are also used for special purposes. The leanness of the ore fixes the blast furnaces on the orefield. Coal is obtainable within a comparatively short distance from the Yorkshire–Derby–Nottingham field. It is clearly a low-cost area. The attention of North Lincoln is concentrated almost entirely on basic pig iron. Being phosphoric, its ores are not suitable for haematite pig and, although it never made much forge and foundry iron, even this has become focused on the East Midlands. Its phosphoric ores are suitable for basic steel made by the Open-Hearth process, but are not sufficiently

[1] *Report* of the Committee on the Restoration of Land Affected by Iron-Ore Working (1939), p. 21. The data for 1937 for the North Lincoln and Midland fields are in acres worked in that year.

	N. Lincs	S. Lincs, Leics, Rutland	Northants
Less than 15 feet overburden .	37	103	56
Over 15 feet overburden . .	26	18	112
Underground workings . .	5	5½	38½

The significance of the distinction between the open-cast workings with over and under 15 feet overburden was that the latter were then capable of being restored without prohibitive cost to normal agricultural employment. For developments since 1939 see the *Report on the Restoration Problem in the Ironstone Industry in the Midlands* (1946), Cmd. 6906. Restoration is now possible if more than 15 feet are removed.

TABLE XLI

Source of Iron Ore and Kind of Pig Iron made, 1949

	East Midlands	Lancs, Yorks	North Lincs	North-east Coast	Scotland	West Midlands	South Wales	North-west Coast	United Kingdom
Source of iron ore in million tons:									
West coast Haematite	—	—	—	—	—	—	—	0·33	0·33
Cleveland . .	—	—	—	0·88	—	—	—	—	0·88
North Lincs . .	0·16	0·07	2·51	—	—	—	—	—	2·74
Other Jurassic . .	4·63	0·38	1·77	0·53	—	0·69	0·41	—	8·41
Total home . .	4·79	0·45	4·28	1·42	—	0·69	0·51	0·33	12·46
W. Europe and W. Mediterranean .	0·28	0·10	0·10	1·23	0·51	0·11	0·84	0·70	3·87
Scandinavia . .	—	0·06	0·07	1·18	0·28	0·11	0·54	0·30	2·55
Total import. .	0·40	0·19	0·19	2·93	1·13	0·31	1·70	1·00	7·86
Kind of pig iron made in million tons:									
Haematite . .	—	—	—	0·41	0·04	—	0·21	0·76	1·44
Basic .	0·73	0·34	1·30	1·86	0·57	0·47	0·99	—	6·25
Forge and foundry .	1·37	—	—	0·02	0·16	0·07	—	—	1·64
Ferro-alloys . .	—	0·07	—	0·07	—	—	—	0·02	0·17
Total . . .	2·11	0·41	1·30	2·37	0·77	0·54	1·20	0·79	9·50

From the Annual Returns of the British Iron and Steel Federation.

phosphoric for basic steel made by the Thomas process (basic Bessemer). The basic pig, of course, is intended for basic steel, and each of the three firms in the district owns both blast furnaces and open-hearth steel works, passing the metal hot from the one to the other.

The East Midland area is unfortunately a composite one for the purposes of the statistical returns of the British Iron and Steel Federation. It comprises the coalfield areas of Derby and Nottingham, as well as the orefield areas of Leicester and Northampton. As late as 1906 Jeans put the East Midlands into the class 'Other Districts',[1] and in 1904 Chapman seemed to be unaware that the East Midland districts were important orefields.[2] Jeans had declared that 'nowadays, nearly all large plants seek . . . a position near a seaport, and thus avoid the costs of handling and transport which are incurred by inland works';[3] this presupposed that all ore was imported from abroad, which was not the case. But at the trade-cycle crest in 1913 the district was growing rapidly; by 1937 it had increased both actually and relatively, having a percentage in that year precisely double that of 1913. It has improved its relative position, though it has not increased its actual output, since 1937. Whether smelting is on the coalfield or on the orefield it is based entirely on Jurassic ores, primarily on the siliceous Northampton ironstone with a small additional charge of calcareous Frodingham ironstone. Five out of six or seven of the companies operating blast furnaces on the coalfield own iron-mines in the Jurassic belt, and one has set up blast furnaces in a branch plant on the orefield. Only small amounts of imported ore are employed and those for special purposes, as in North Lincoln. The ores are cheaply worked by surface quarrying methods, though some underground mining is unavoidable.[4] The high-phosphorous ores are made almost entirely into forge and foundry pig and, to a lesser extent, into basic pig for basic steel-making. Until recently, difficulties were experienced in using Northampton ironstone (except by admixture with other ores) for making basic steel, and it was not until the application of methods devised by Stewarts and Lloyds, at Corby, that basic steel, and therefore basic pig iron, production developed in the district on any large scale. The coke charged is from the Yorkshire–Derby–Nottingham field. Foundry and forge pig are becoming concentrated increasingly

[1] J. S. Jeans, *The Iron Trade of Great Britain* (1906), p. 36.

[2] S. J. Chapman, 'The Report of the Tariff Commission on the Iron and Steel Trades', *Economic Journal* (1904), vol. XIV, p. 619. This is the construction that Burn (p. 311) puts on Chapman's statement, but Chapman referred to the *Midlands* and it is probable that it was of the West and not of the East Midlands that he was thinking.

[3] Jeans, op. cit., p. 41.

[4] Underground mining is not only more expensive in labour, but more wasteful in iron resources for some ore (10–40 per cent) must be left underground which would be worked by open-cast methods. On the other hand, less damage may be done to surface agricultural land.

into this district, and in 1949 it made over four-fifths of the total for the United Kingdom. This concentration is due partly to the low-cost character of the area, partly to the good forge properties of phosphoric iron, and partly to the centrality of its position relative to the main concentrations of forges and foundries in the country. Both orefield and coalfield furnaces participate in this concentration of attention on forge and foundry pig. There is a striking contrast between the Don Valley with its steelworks and Derby–Nottingham with its blast furnaces. The orefield plants are adjacent to the ironstone quarries and the coalfield furnaces are along the western margins of the coalfield, that is, on sites which supported iron industries in the first phase of the coke-iron industry. Although not necessarily on the exact site at which coking coal is made, some of the coalfield furnaces are only a few miles distant from coke ovens. Of the orefield plants only that at Corby has its own coke ovens on the same site as the blast furnaces.

The North-west Coast areas of Furness and West Cumberland attained their maximum level of pig-iron production in the 'eighties of the nineteenth century. The importance of the district was due to its high-quality ores, and when the output of these began to fall after the 1880–4 quinquennium[1] the output of pig iron also began to decline. Ores of similar quality began to be imported from abroad, but, although imported ores as a percentage of total ore consumption was increasing, not until the 1940's did they exceed home ore. The supply of home ore, however, is limited and large increase in output of pig iron is dependent, as on the North-east Coast, on foreign supplies.[2] The North-west Coast local ores are siliceous and substantial amounts of limestone quarried close by need to be added to the furnace charge. Some Cumberland coke is used, but much coke is also brought in from Durham by rail at considerable cost. It is probable that in 1937 little more than one-third was local coke. It makes little but haematite pig, for which its high-grade non-phosphoric ores are eminently suited, and haematite pig has come to be concentrated on the North-west Coast and on the North-east Coast. The blast furnaces are strung along the coast, in West Cumberland and in Furness, locations which reflect the use of imported as well as of home ore and the shipment of much of the pig iron coastwise.

Scotland was the second pig-iron district in the United Kingdom in 1913, though its percentage had been declining throughout the

[1] From $2\frac{1}{2}$ to $2\frac{3}{4}$ million tons in the 'eighties of the nineteenth century to $1\frac{1}{2}$ million tons in the first decade of the twentieth century, to $1\frac{1}{4}$ million tons in 1927–9, to 0·8 million tons in 1937 and to 0·35 million tons in 1949.

[2] The net selling value of the haematite ore at mine per ton was in 1937 19*s.* 4*d.* for ore containing 52 per cent Fe, as compared with 7*s.* 2*d.* for Cleveland ironstone (29 per cent Fe) and 3*s.* 5*d.* for Northampton ironstone (32 per cent Fe). The value of imported ores at the point of import was 22*s.* 7*d.* in 1937. Values for recent years have not been made available.

second half of the nineteenth century. By 1929, however, it had fallen to sixth place, and it has since remained there. Its output in 1937 was little more than one-third of what it had been in 1913 and its decline has been the most pronounced of all districts. Its output has since increased considerably above the 1937 level. The great importance in the past was due to the use of local black-band ores and of local splint coal. The ores, containing much carbonaceous material, were smelted in small furnaces, the average size of blast furnaces in Scotland being less than in any other district.[1] The small furnaces made possible the use of splint coal in place of coke. The black-band ores, moreover, were particularly suited for forge and foundry pig, then in large demand. Compensation was sought for the decline in the output of black-band ores, which had fallen to 0·6 million tons in 1913 and to negligible amounts in 1929, by imports of foreign ores on which Scottish blast-furnace practice is now wholly dependent. The blast furnaces, however, were located on the central coalfield in the lower Clyde Valley, and, therefore, in an unsuitable position for the receipt of foreign ores. The decline in the available supplies of splint coal and the lack of coking coal were factors which could not be remedied so easily, for coking coals are scarce in Scotland although several coals are suitable for blending. A project for the erection of blast furnaces and of an integrated steel plant on the Firth of Clyde, where foreign ores could be unloaded overside, was advanced during the inter-war period, and has been advanced again recently.[2] The Scottish output is coming to be chiefly of basic pig.

South Wales had already become one of the minor pig-iron districts by 1913, though in 1855 it had been surpassed by the West Midlands alone (see Table XXXVIII), but since 1913 there has been no further deterioration in its relative position. Output has increased since 1937 and will shortly increase still further. Decline had been due to the same causes as in Scotland, the growing expense of mining Coal Measures ores, and compensation had been sought in the same way, by import of foreign ores. Unlike Scotland, however, a locational shift had occurred in South Wales for blast furnaces had been set up to receive imported ores. Comparatively few of these now remain. The latest locational changes are, first, the reconstruction of the Ebbw Vale furnaces, a 'hill' site in the north-east

[1] During the war the average annual output per furnace increased to a level above that of the West Midlands.

[2] The project is discussed in *An Industrial Survey of the South-west of Scotland* (1932), pp. 152–6. It is discussed also by D. L. Burn, op cit. In the early part of 1937 extension of the inland plant at Clydebridge (a plate mill, steel furnaces, blast furnaces, and coke ovens) was decided on in preference to rebuilding on an entirely new site on the Firth of Clyde. The decision taken was in order to save capital expenditure on an entirely new plant, although it was realized that pig iron would cost several shillings more per ton at Clydebridge. The *Report of the British Iron and Steel Federation on the Iron and Steel Industry* (Cmd. 6811) proposes such a blast furnace and steel plant on the Clyde.

part of the coalfield, along with a reorganized steel and tinplate plant. The adoption of this site was alternative to a transfer from the South Wales coast to North Lincoln. From the standpoint of the general trends in the location of pig-iron production the change would appear to be doubly retrograde, to stay in South Wales rather than to move to North Lincoln and to transfer from the South Wales coast to a hill site in interior South Wales, a type of location that was being abandoned in the latter half of the nineteenth century. The hill site, however, has local coking coal which can be carbonized in the works and whose waste gases can be utilized in subsequent processes of manufacture. By reason of its efficiency, a new well-planned integrated plant might hope to counterbalance disadvantages of site, but, it may be argued, it would be still more efficient on a favourable site. There seems no doubt that social reasons contributed largely to the decision, and it aroused strong differences of opinion among the shareholders and directors of the company involved. The second change is the new integrated plant at Margam on the coast (see p. 349 below). South Wales to-day is not completely dependent on foreign ore. Some haematite is mined along the south crop of the coalfield and some Northampton ironstone is brought in by rail.[1] There is no lack of good coke. Only haematite and basic pig are made, but the former was declining until 1937, though it has now been stabilized and the latter is still increasing, the change in both cases in the inter-war period being greater than in Great Britain as a whole.

Blast-furnace production in the West Midlands had been declining in the second half of the nineteenth century along with that of South Wales, and decline was again due to the increasing expense of working Coal Measure ores. The West Midlands had fallen from first place in 1855 to sixth place in 1913, and the district has continued to fall since, to eighth place in 1929, 1937 and 1949. It could not seek compensation, as could Scotland and South Wales, by import of foreign ores owing to its inland situation; but the Jurassic ores of the East Midlands were available. Local coke supply appears insufficient, and some coke is brought in from larger fields farther north. Comparatively little forge and foundry pig are now made, and these are in small furnaces and of special qualities. The output of the West Midlands is now chiefly basic pig. Neither the Coal Measure nor the Jurassic ores are suited for haematite pig. The West Midland furnaces frequently do not work to full capacity, and in 1937 the district had the lowest number of blast furnace weeks in blast per furnace (twenty out of a possible fifty-two) of any district, lower even than Scotland. This is clearly consequential on its position relative to supply of material, having only partial supplies of both coke and

[1] This is a very long haul for such lean ores, but the orefields are worked by the company and presumably the reason for the long haul is bound up with this circumstance. Billets and slabs of steel are brought also from North Lincoln.

ore, and on the specialized market served by the furnaces making forge and foundry pig.

The last region is that comprising the few furnaces in South Lancashire, North Wales, and West Yorkshire. This group has never been among the foremost smelting districts, neither in the nineteenth century nor in this. In 1913 its total output of pig was scarcely greater than that of North Lincoln, whose development had barely begun, and in 1929, 1937 and 1945 it only just exceeded that of the West Midlands, whose output was the lowest of all districts. But, although at a low level, the production of the group has remained strikingly steady at trade-cycle crests. As in the West Midlands, basic pig is now the chief product. Of the ore used the greater part is from the Jurassic belt, which involves a long haul for that sent to the west of the Pennines. A good deal of the ore employed is calcareous and the amount of limestone added to the charge is comparatively small. All the sites of blast furnaces are located on the coalfields, usually on those parts of the coalfield that were worked early, that had an iron industry prior to 1850, and that still have coking coal comparatively near at hand. The Irlam plant in Lancashire alone is a new site, representing a transfer to the banks of the Manchester Ship Canal from Haigh, near Wigan, an initial site which was comparable in all respects to the other furnaces within this group.

III

REGIONAL ANALYSIS OF STEEL-MAKING

The smelting of the ore and the production of pig iron, however, is only the initial process: pig iron is brittle and contains many impurities. It must undergo further treatment before it can be made into cast iron, wrought iron, or steel. The proportion of the total pig-iron output that is made into cast iron and wrought iron has been declining ever since Bessemer steel began to be made. The rate of decline, however, is diminishing, and it would appear that a fixed, though restricted, market persists. Cast iron is particularly suitable for hollow-ware designed to hold liquids; it resists corrosion and rust. Wrought iron has pronounced welding properties and is very resistant to sudden shock; it is used, for example, in tubes and in railway couplings. It is employed also in ornamental iron work where workability to meet the requirements of design is the primary consideration. The geographical distribution of cast iron and of wrought iron manufacture will be considered first before the geographical distribution of steel-making.

Cast iron is made in the foundry whereby the iron attains greater strength, but its chemical composition is unaltered and much of the brittleness of pig iron remains.[1] Iron foundries are widely distributed

[1] The charge includes as much scrap as pig iron.

and are found in centres of iron and steel consumption as well as in centres of primary iron and steel production. They display the same large degree of mobility, and for the same reasons, as the finished iron and steel trades which will be discussed later in this chapter. The consideration of iron founding at this stage is thus anticipatory, but it is convenient to deal with it here as it is related technically, but not geographically, to pig-iron manufacture. Every part of the country, indeed every town, has its foundries. They are not, it is true, in strict proportion to population, for Scotland has twice its share and the West Midlands two and a half times its share and, correspondingly, some other areas, notably Greater London, have under their share. But the geographical distribution of iron foundries is very much more diffused than the geographical distribution of blast furnaces, of steel works, or of puddling furnaces. This wide diffusion of foundries is paralleled, as might be expected from their closer relation to direct consumption, by a smaller average size of establishment than either blast furnaces or steelworks and rolling mills.[1] The smaller size is least pronounced in the centres of primary iron and steel production and is true chiefly of towns removed from iron and steel producing districts. Many town foundries, in fact, are jobbing foundries which do not produce standard castings to stock, except to a limited extent, and are mainly employed in making castings to specification as and when required. For making castings, foundries use large quantities of moulding sands, but these are fairly widespread, ranging from the Carboniferous to the glacial and post-glacial, and exercise no limitation to the location of foundries. The formation which is worked most extensively for the purpose is the Triassic, and the moulding sands of the Trias are within ready access of the Lancashire, Yorkshire, and West Midland foundries. In his memoir on British Refractory Sands, Prof. P. G. H. Boswell gives it as his opinion 'that each of our steel-producing areas may to no small extent be self-supporting' in moulding sands, even though steel founding requires fresh sand on each occasion, while in iron founding moulding sands may be employed over and over again.[2] The Joint Iron Council in its Report to the Minister of Supply declared that it was 'not possible . . . to recommend any fundamental changes in the general location of iron foundries'.[3]

The puddling process which produces wrought iron makes a more refined and tougher iron than cast iron, but it is laborious, involves a longer time and a greater quantity of fuel than cast-iron manufacture.[4]

[1] The average number employed per establishment at the time of the 1935 Census of Production was 129 for foundries, 329 for blast furnaces, and 425 for steel works and rolling mills.

[2] P. G. H. Boswell, *A Memoir on British Resources of Refractory Sands for Furnace and Foundry Purposes* (1918).

[3] Cmd. 6811, p. 49.

[4] The process involves the melting of pig iron, the careful collection of the

Puddling furnaces are limited with scarcely an exception to the coalfields of the West Midlands, the West of Scotland, Yorkshire–Derby–Nottingham, Lancashire, and the North-east Coast, in that order. These were all sites of iron manufacture in the first phase of the coke-iron industry and, with the addition of South Wales, had again, with scarcely an exception, all the puddling furnaces existing in 1860–5.[1] It is the older rather than the newer iron centres that are involved. In respect of geographical location, therefore, wrought-iron manufacture has displayed remarkable stability. This is perhaps to be expected from its character as a relic industry, for it is expanding rather than contracting trades that are most ready to change their site of operation. Out of twenty-six firms having puddling furnaces in 1939, only three were associated with blast furnaces, and of these only one had its puddling and its blast furnaces on the same site: of the twenty-six firms, only two had steel works, and these were on other sites, though in the same part of the country. Wrought-iron manufacture thus very largely stands aside from integration. The average output per firm is small and is much too small to be able to employ the total production of a blast furnace; moreover, much of the output is of high-quality iron whose quality rather than cost is the primary consideration. There would seem, therefore, to be little urge to integration. All puddling furnaces have rolling-mills attached, usually bar-mills, and the product is sent out, where not finally manufactured on the same premises, in the form mainly of bar iron. The finest quality is 'Best Yorkshire' iron made with great care and from specially pure materials solely in the neighbourhood of Bradford and Leeds in the West Riding of Yorkshire; it is employed mainly in making critical parts of locomotives, of mining gear, and of marine engines, where possibility of breakage must be avoided at all costs. Other qualities of wrought iron are used for the same purposes, for cable and chain-making, for railway couplings and for horseshoes, for all of which purposes toughness and capability of withstanding shock, as well as strength, are necessary. Wrought iron is capable of being manipulated to shape in the smithy, and it will probably always retain value for various articles which require a smith's treatment. The forges working up wrought iron into finished articles are widely dispersed in consuming centres and are as ubiquitous as iron foundries.

Apart from special steels, steel is made by one of four methods: the acid Bessemer, the basic Bessemer, the acid Open Hearth and

refined iron into a ball while molten in the furnace, the oft-repeated hammering of the iron ball so that its separate particles become firmly welded together.

[1] Out of 420 puddling furnaces listed in *Ryland's Directory* for 1940, the West Midlands had 159, Scotland 120, Yorkshire–Derby–Nottingham 71, Lancashire 58, the North-east Coast 12. The numbers in 1865, according to Hunt's *Mineral Statistics*, were, in the West Midlands 2,702, Scotland 383, Yorkshire–Derby–Nottingham 686, Lancashire 109, the North-east Coast 1,096, South Wales 1,332, the total in that year being 6,407.

the basic Open Hearth. As these not only require pig iron of different composition and produce steels suitable for different purposes, but have differing geographical distributions, it is necessary to consider briefly their separate characteristics.

Bessemer steel, whether acid or basic, is made within the short space of twenty or thirty minutes in a converter. Owing to the rapidity with which the process is accomplished the composition of the steel cannot be controlled during manufacture as readily and as precisely as by the Open Hearth process. The pig iron employed in the Bessemer process is usually hot metal brought direct from the blast furnaces, thus economizing fuel; indeed, Henry Bessemer initially described his process as one making steel without fuel. Bessemer steel plants are thus located on the same sites as blast furnaces,[1] which themselves tend to be placed increasingly, as we have seen, on the orefields. Little scrap is added and the location of the plant is not affected by the location of supplies of scrap. The distinction between acid Bessemer and basic Bessemer will be considered shortly.

Open Hearth steel, whether acid or basic, requires a more prolonged period—some twelve hours—for its manufacture.[2] Cold pig iron, as well as hot, is used, and large quantities of cold scrap are added.[3] The fuel requirement, therefore, is not inconsiderable. The usual practice is to fire the furnaces by gas which may be produced direct from coal or, in the case of an integrated plant, from by-product coke ovens and from blast furnaces. But, as material is charged in small quantities at regular intervals, the manufacture of Open Hearth steel can be supervised more closely and the product can be tested frequently during the course of manufacture. A steel more exactly to specification is the result, and, partly for this reason, Open Hearth steel has tended to replace Bessemer steel. Thus, in South Wales, while the older steel plants in the hill areas were Bessemer plants, the newer ones along the coast were Open Hearth. The use of cold pig and of cold scrap has consequences in respect of location. The use of cold pig makes possible a site removed from blast furnaces, though manufacture is more expensive than if hot metal were charged, and the use of large quantities of scrap encourages proximity to scrap supplies; that is, to machine-making, engineering,

[1] In evidence before the Balfour Committee on Industry and Trade, a witness put the maximum permissible distance between blast furnace and steel works for the use of hot metal as a mile or half a mile (*Minutes of Evidence*, vol. I, p. 87).

[2] The difference is shown by the relation between output capacity and actual output. Annual output in 1937 *per ton of capacity* was 450 tons for Open Hearth steel plants, but for Bessemer steel plants it was approximately ten times as great.

[3] Returns made in 1916–17 to the British Association Fuel Economy Committee gave 6·35 cwt. of coal per ton of steel for four plants working in conjunction with blast furnaces and with charges of 85 per cent + of molten pig iron, and 9·45 cwt. of coal per ton of steel for three plants charged wholly with cold pig and cold scrap (Bone and Himus, op. cit., pp. 486–7).

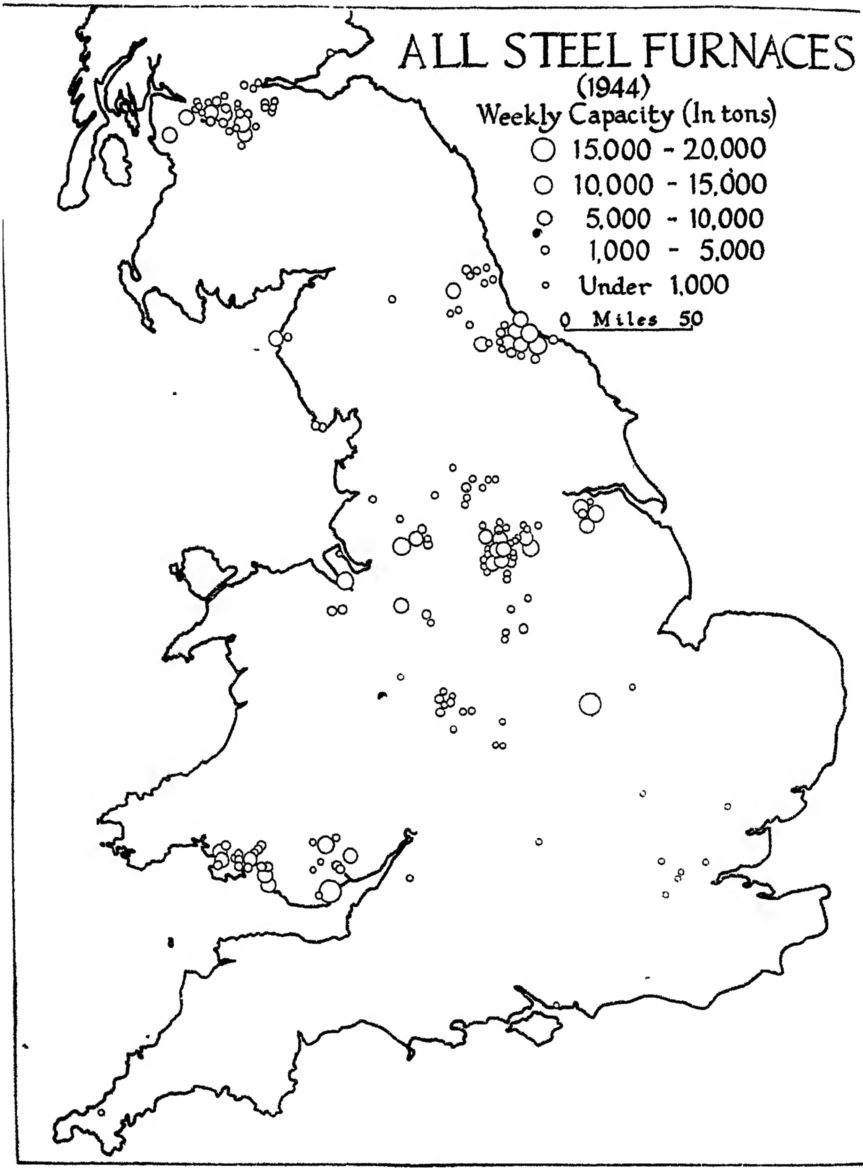


Fig. 46

STEEL FURNACES IN GREAT BRITAIN

The map includes all steel furnaces, acid and basic, Bessemer, Open Hearth and electric. Overlapping circles employed in order to increase size of symbols and so improve readability of map. *By permission of the Ordnance Survey.*

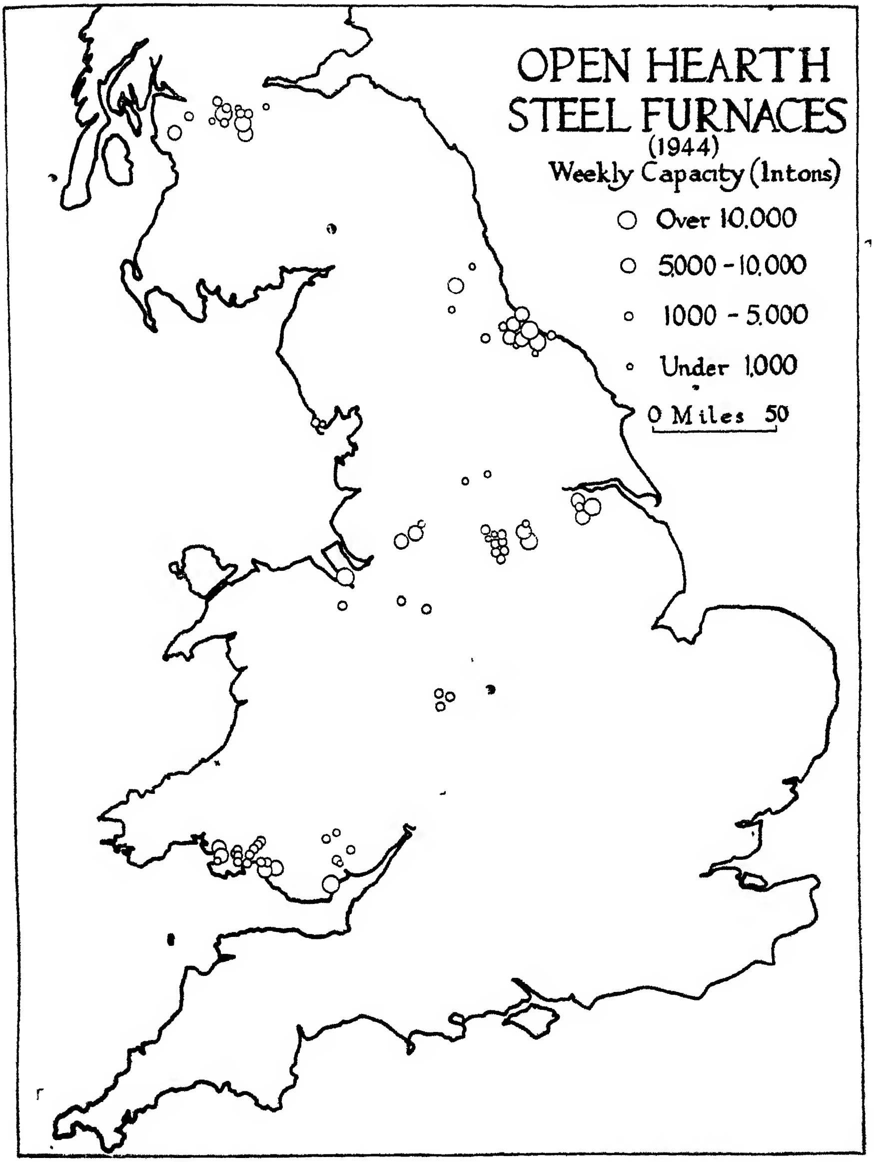


Fig. 47

OPEN HEARTH STEEL FURNACES IN GREAT BRITAIN

The map includes all Open Hearth furnaces, acid and basic. Overlapping circles employed in order to increase size of symbols and so improve readability of map. *By permission of the Ordnance Survey.*

shipbuilding and repairing districts.[1] Open Hearth steel-making, in fact, is widely distributed, in engineering districts and on the site of engineering plants as well as in smelting districts and on the site of blast furnaces. Open Hearth furnaces are on the site of railway shops at Crewe equally as on the site of blast furnaces at Frodingham–Scunthorpe. The advantage of proximity to consuming industries is in proportion to the amount of scrap in the charge. This has varied very considerably in the course of time. Taking the total steel industry, Bessemer and Open Hearth together, pig iron exceeded scrap up to 1929, but since that date scrap has consistently exceeded pig iron. In 1937 the scrap percentage was 54 and in 1949 58. Open Hearth steel-making could be adopted piecemeal and in relatively small units: it required much less capital than the elaborate Bessemer plant and was within the capacity of malleable iron manufacturers who were turning over from wrought iron to steel. Many malleable ironworks (in Scotland, in the West Midlands, and on the North-east Coast) thus became Open Hearth steelworks in the last decades of the nineteenth century, as Burn has shown.[2] The significance of this in respect of location is that the malleable ironworks, developed in the first phase of the coke-iron industry and dependent on both coal and ore from the Coal Measures, were on the coalfields. They became Open Hearth steel-makers on their old site and were able to utilize their existing rolling-mill equipment and their existing markets which in many instances were close at hand also. Moreover, the small unit of the Open Hearth steel furnace itself permitted relatively wide diffusion.

Both Bessemer and Open Hearth processes are subdivided according to whether they make acid or basic steel. The acid furnaces have a siliceous ganister lining and the pig iron charged must have negligible amounts of phosphorus and sulphur as the lining is incapable of removing them. Acid steel-making is thus dependent on haematite pig, low in both phosphorus and sulphur. The basic furnaces have a calcareous limestone lining, and this, with the aid of small quantities of limestone added to the charge, eliminates the phosphorus. Basic steel-making thus requires pig iron low in silicon and sulphur, but it can utilize pig relatively high in phosphorus. The basic Bessemer (Thomas) and basic Open Hearth differ in that the first requires a pig iron with a minimum phosphorus content of 1·7 per cent and that the second can employ pig iron with less than 1·7 per cent of phosphorus. Of British Jurassic phosphoric ores, only Northampton ironstone produces a sufficiently high phosphoric pig

[1] There are two kinds of scrap—process scrap produced in the course of steel-making, machine manufacture and engineering, and old scrap from demolition of buildings, ships, etc. Of the scrap used in 1950, 4·21 million tons was from steel works and rolling mills, 0·60 from re-rollers, 1·75 from machine makers and engineers and 1·60 capital or old scrap. *Bulletin Brit. Iron and Steel Federation*, vol. XXVI, no. 2.

[2] Burn, op. cit., pp. 238–40.

to be satisfactorily employed in making Thomas steel by the basic Bessemer process. Lorraine ores are eminently suited to the Thomas process. In the nineteenth century there were Thomas steel plants on the North-east Coast, in Scotland, and in the West Midlands, but one by one they ceased to operate or were converted to basic Open Hearth.[1] It was not until the middle thirties of this century that the basic Bessemer process was reintroduced, first by Stewarts and Lloyds at Corby in Northampton, and later by Richard Thomas and Company at Ebbw Vale, where Northampton ore is also used. Basic Open Hearth furnaces are much more generally distributed. Acid Bessemer is also limited in distribution, in this case to West Cumberland on the site of the only haematite orefield of substantial size in Britain. Imported haematite ore is handled mainly by acid Open Hearth plants. With the exception of the Ebbw Vale plant, whose location is exceptional in many respects, the Bessemer plants are thus on the orefields and in districts where engineering (and therefore scrap-producing) industries are absent. The Open Hearth plants are more tolerant in their locational requirements; they are to be found alike on orefields and on coalfields, on the sites of blast furnaces and of consuming (that is, metal-using) industries.

The output of steel in Great Britain to 1914 is shown in Fig. 16. While the output of pig iron declined during the inter-war years that of steel has continued to grow. More steel than pig iron is now manufactured and the difference is made up by imports of pig iron and of scrap as well as by the use of scrap produced within the country.[2] This steel production, like that of pig iron, also represented prior to the 'thirties a declining share of world output, but the decline was not as pronounced.[3] As in pig iron, the percentage has tended to increase both in the 'thirties and in the contemporary period, and steel as well as pig-iron production would appear to have attained a steady share of world output. The actual output, of course, rose rapidly up to the trade-cycle crest in 1937, an increase due largely to the trade-cycle fluctuation, but also accentuated by protection and by rearmament. The net annual addition in the quinquennium (1933–7) due to tariffs has been estimated at 0·5 and the addition in 1937 due to rearmament at 3 million tons.[4] It remained at a high level during

[1] This has been described as a weakness in the competitive position of Britain at a time when her relative status in world iron and steel production was declining (T. H. Burnham and G. O. Hoskins, *Iron and Steel in Britain, 1870–1930* (1943)).

[2] The 1937 returns in million tons were: pig-iron output, 8·49; steel output, 12·98, pig iron used in steel, 6·26; scrap used in steel, 7·48. The 1949 returns were 9·50, 15·55, 7·09 and 9·77 million tons respectively. Efforts are being made to expedite the circulation of scrap.

[3] For an analysis of the causes of this decline in relative share and for an appraisal of the extent to which it was within the control of the industry, see Burnham and Hoskins, op. cit.

[4] E. D. McCallum, 'The Iron and Steel Industry' in *Britain in Recovery*, ed. by J. H Jones (1938), pp. 371–2.

the war and increased steadily during 1948, 1949 and 1950 to double the output of 1913.

The four processes employed in steel-making on a large scale have varied in relative importance in the course of time. The first variation is the long-term decline of the Bessemer and the long-term increase of the Open Hearth, for reasons indicated earlier. In recent years, however, there has been a revival of the basic Bessemer process in the treatment of high-phosphorus Northampton ironstone which alone of the ores worked in Britain to-day on a substantial scale is suited to the making of Thomas steel. The second variation is the relative decline of acid steel and the increase of basic steel. The decline is common to acid Open Hearth and acid Bessemer, the whole of the increased output having been of basic steel. This increase includes both basic Bessemer and basic Open Hearth, but particularly the latter.

Let us now turn to the regional pattern of steel-making and consider its location more specifically, backwards in relation to blast furnaces and forwards in relation to rolling-mills and steel-using industries. A distinction was drawn in the distribution of blast furnaces, it will be remembered, between those in the Jurassic belt, those on the haematite field, and those on the coalfields. The Jurassic areas (together with Derby and Nottingham) produced 29·6 per cent of the steel in 1913, 30·5 in 1929, 35·0 in 1937, and 34·3 per cent in 1949: the coalfield areas produced 65·2 per cent in 1913, 67·1 in 1929, 62·0 in 1937, and 63·1 per cent in 1949: the haematite area 5·2 per cent in 1913, 2·4 in 1929, 3·0 in 1937, and 2·6 per cent in 1949. These proportions present considerable differences from those of blast furnaces. The Jurassic belt and the haematite area have each a smaller proportion of the production of steel than of pig iron, and the coalfield group has a larger proportion. The coalfield proportion of steel output was declining before the war, it is true, but at a slower rate than its proportion of pig-iron output. Conversely, the proportion of steel made in the Jurassic belt was increasing, but at a slower rate than its proportion of pig iron. These changes as between Jurassic belt and coalfields have now come to a halt. Steel production is thus located to only a limited extent at the sources of ore supply. In 1937 approximately one-half of the steel plants were owned by firms which had blast furnaces in the same district, though not necessarily on the same site.[1] The integrated plants were mainly on the orefields. The orefields have independent smelters exporting their pig out of the district, but they have scarcely any independent steel-makers. The coalfields have many steel works independent of blast furnaces and a few blast furnaces independent of steelworks, but these last make

[1] These firms had 105 out of the 200 blast furnaces and 244 out of the 448 Open Hearth furnaces and Bessemer converters. These figures have been calculated from the 1937 returns of the British Iron and Steel Federation.

TABLE XLII

Output of Steel Ingots and Castings by Districts

	East Midlands and Lancs and Yorks	Sheffield	North Lincs	North-east Coast	Scotland	West Midlands	South Wales	North-west Coast	United Kingdom
Actual quantities in million tons:									
1913	0·51	0·88	0·24	2·03	1·43	0·36	1·81	0·40	7·66
1929	0·77	1·22	0·73	2·21	1·58	0·55	2·34	0·23	9·64
1931	0·36	0·78	0·39	1·14	0·68	0·42	1·27	0·16	5·20
1937	1·51	1·74	1·30	2·82	1·90	0·70	2·63	0·38	12·98
1949	1·92	2·13	1·48	3·21	2·38	0·80	3·22	0·40	15·55
Index numbers:									
1913	100	100	100	100	100	100	100	100	100
1929	151	138	304	109	111	152	129	59	126
1931	71	88	163	56	47	115	70	40	68
1937	295	198	538	139	132	192	145	97	169
1949	376	242	618	158	167	222	178	101	203
Percentages of United Kingdom:									
1913	6·7	11·5	3·1	26·5	18·7	4·7	23·6	5·2	100
1929	8·0	12·6	7·6	22·9	16·4	5·8	24·3	2·4	100
1931	7·0	14·9	7·5	21·9	13·0	8·1	24·5	3·1	100
1937	11·6	13·4	10·0	21·8	14·6	5·4	20·2	3·0	100
1949	12·4	13·7	9·5	20·7	15·3	5·1	20·7	2·6	100

Lancashire and Yorkshire represents the residual area of those counties exclusive of Cleveland, attached to the North-east Coast, of Furness, attached to the North-west Coast, and of Sheffield, separately distinguished; it includes also Cheshire, Denbigh, and Flint. The East Midlands includes Derby and Nottingham as well as Northampton and Leicester.

Extracted or calculated from the Annual Returns of the British Iron and Steel Federation.

mostly forge and foundry iron for the finished iron trades which are themselves located primarily on the coalfields. It is arguable up to a point that *iron* smelting on the coalfields represents a relic industry established at the time when iron smelting from Coal Measure ores was focused on the coalfields. But this, while true historically of the iron smelters making for the finished iron trades, is true historically to only a limited extent of *steel*-making, for steel-making did not develop in bulk until after the smelting of Coal Measure ores had begun to decline. Some steel-makers had been previously malleable iron-makers, but not all steel-makers had evolved thus. An equally significant reason for the location of so many steel plants on the coalfields is the presence of steel-using industries which produce large quantities of scrap and which are in the hands of firms which themselves make steel. The geographical distribution of the steel-using industries, of course, will be considered later.

The two largest steel producers are the North-east Coast and South Wales. The North-east Coast has a steel output to-day greater than its pig-iron output, although as late as 1929 pig iron exceeded steel. The district had long been an exporter of pig iron to other districts within Britain and abroad.[1] It still retains this character, and of the pig-iron made in 1937 under three-quarters was made into steel in the district itself.[2] The residue available for steel-making in other districts is thus substantial. The surplus pig is sent over the whole country, but especially to Sheffield, South Wales, and Scotland, areas which have a deficiency of pig-iron production over their requirements for steel-making.[3] The pig exported from the district is chiefly haematite pig, almost the whole of the basic pig being required locally for the production of basic steel, now the chief kind of steel made. The greater part of the pig is charged hot into the furnace and practically every steelworks has blast furnaces attached or else owned by the same firm within the district. Most of the smaller steel plants independent of blast furnaces have ceased to operate. It is not without point in this connexion that the average size of furnace and of plant was well above the national average, and is, in fact, second only to North Lincoln. It is significant, too, that the pig iron–scrap ratio in steel-making is different on the North-east

[1] The Balfour Committee on Industry and Trade described the North-east Coast as 'the most important iron and steel manufacturing district which produces a surplus of pig iron' (*Survey of Metal Industries* (1928), p. 20). With the continued development of the East Midlands since the date of that *Survey* (1928) it is no longer the chief district in this respect.

[2] The figures in million tons were: pig-iron production, 2·43; basic and haematite pig, 2·29; pig employed in steel production, 1·75; pig-iron import, 0·03; pig-iron export, 0·07. Basic and haematite pig sent to other districts within Britain, unless accumulated as stocks, would thus appear to have been 0·5.

[3] Shipment of pig iron by sea is considerably cheaper, wherever sea shipment is possible, than transport by rail, amounting approximately to only half the rail charges. For the longer distances the relative advantage of sea shipment is greater than this, for the shorter distances less.

Coast from the ratio in the country as a whole, relatively more pig and relatively less scrap being used in this pig-iron district. The relatively small amount of scrap employed is almost limited to process scrap produced within the steel plant and attached rolling-mills. The steelworks, almost to the same degree as blast furnaces, are focused on Teeside and on that part of Teeside with access to ocean-going vessels. The axial line extends through Redcar and Middlesbrough to Stockton, with wings along the coast north to West Hartlepool and south to Skinningrove. The only outliers are the important steel furnaces at Consett in the West Durham coalfield.[1]

Lincolnshire, though not originally so, is now a much more self-contained district. Virtually the whole of the pig-iron output is made into steel and is charged hot into the furnace; most of the pig is basic and most of the steel basic Open Hearth. Coke ovens, blast furnaces, and steel plants are integrated on the same sites; there are no independent blast furnaces and no independent steel furnaces. But it was not until after 1932 that steel production balanced pig-iron production, and in 1913 pig-iron output had been double steel output, the area then being a pig-iron exporter.[2] This is the only district where integration is so complete. Steel output is greater than pig-iron output, but the proportion of scrap added is the least of any district. Being thus situated on the same site as blast furnaces, themselves on the site of the orefield, steel-making in North Lincoln offers conditions suitable for low-cost production. Coal or coke, however, has to be brought from a distance, but the Yorkshire–Derby–Nottingham coalfield is relatively close at hand. It is, therefore, understandable why the district was increasing its share of the steel[3] as well as of the pig-iron output of the country, why firms previously established elsewhere have moved into or acquired plant in the district, and why, in order to take full advantage of these opportunities, every steel plant in North Lincoln has an output capacity in excess of the median output capacity (358 tons in 1939) of steel plants in Great Britain as a whole.

The East Midlands produces considerably less steel than pig iron. It will be recalled that the greater part of the pig iron made in the

[1] The *Report of the British Iron and Steel Federation on the Iron and Steel Industry* (1946), Cmd. 6811, includes particulars of reconstruction on this site. Its retention appears to be unquestioned.

[2] The Redbourn Hill plant of Richard Thomas & Company, for example, originally consisted of blast furnaces only, and continued to be an iron smelter sending its pig to other districts. It was then jointly acquired by the Cwmfelin Steel and Tinplate Company of South Wales, tinplate makers, and by Monks, Hall & Company of Warrington, bar makers. This was naturally the first development in a new district located on an orefield: the addition of steel-making came later. John Lysaght was previously a re-roller at Newport, in South Wales, and later went into pig iron and steel-making at Normanby Park, Scunthorpe. The re-rollers were thus working backwards and establishing themselves as pig-iron and steel-makers.

[3] The 1937 level of steel output has not since been exceeded

district is forge and foundry pig. Much of this forge and foundry pig is made up into finished consumption goods in the district, which in statistical returns includes Derby and Nottingham as well as Northampton and Leicester, but some is sent into finished iron districts elsewhere. The Stewarts and Lloyds basic Bessemer plant at Corby represents a recent migration to the orefield on the part of a firm previously established elsewhere, in Scotland and in the West Midlands, in order to take advantage of the lower costs of production in an integrated plant on the orefield. There are blast furnaces, coke ovens, and steelworks side by side, pig being charged hot into the furnaces and ore and limestone being quarried near by. This instance of migration is thus harmonious with migration into North Lincoln. An entirely new integrated plant, ranging from coke ovens to a continuous billet-mill, is contemplated on the Northampton orefield, according to the *Report* of British Iron and Steel Federation to the Minister of Supply. Although coke or coal has to be transported from a distance in the case of both Northampton and North Lincoln, this is less costly than transporting Jurassic ore with a low iron content to a coalfield site: the ratio of *coal equivalent* to iron ore used in the blast furnaces of each district is approximately 3 : 5. The Corby plant is the only substantial maker of steel in this group: its charge is of hot pig with very little scrap. This statistical unit, in fact, is made up of two distinct parts: (*a*) the basic Bessemer plant at Corby on the orefield, the only steel plant among a group of blast furnaces making forge and foundry pig; (*b*) a group of blast furnaces on the Derby–Nottingham field making forge and foundry pig and with only a few very small steelworks, the complementary site on the coalfield to (*a*). The Lancashire–Cheshire, Yorkshire and North Wales plants (excluding those of Furness, Sheffield and Tee-side) are widely scattered. They comprise (*a*) a number of small electric and tropenas furnaces in the machine and engineering districts of Manchester and West Yorkshire, (*b*) the Brymbo works near Wrexham, (*c*) the Irlam plant on the Manchester Ship Canal, and, (*d*) the Shotton works on Deeside. Only the Irlam and Brymbo plants have blast furnaces, though it is planned that Shotton also will have blast furnaces in the future. All other plants are integrated forwards with rolling-mills rather than backwards with blast furnaces.[1]

[1] These basic steel plants use not inconsiderable quantities of imported basic pig, the ports from the Mersey to the Solway being third to Scottish and Bristol Channel ports in their imports of basic pig. Individually, the largest of these is the Shotton works, on Deeside. It is fairly well placed for the receipt of imported pig and for the export of finished products, through Birkenhead in each case, and it is technically efficient, with a continuous sheet plant which began operation in 1939. But it has some disadvantages. At present it obtains its pig from the Shelton Works, in North Staffordshire, the parent establishment, and there is no pig-iron production on the Shotton site. The proposals of the British Iron and Steel

TABLE XLIII

Production of Steel by Process, 1949

	East Midlands	Lancs and Yorks	Sheffield	North Lincs	North-east Coast	Scotland	West Midlands	South Wales	North-west Coast	United Kingdom
Quantities in million tons:										
Acid Bessemer	—	—	—	—	—	—	—	—	0·23	0·23
Basic Bessemer .	0·54	—	—	—	—	—	—	0·28	—	0·82
Acid Open Hearth .	—	0·09	0·43	—	0·08	0·23	—	0·51	0·03	1·31
Basic Open Hearth .	—	1·12	1·28	1·48	3·07	2·02	0·73	2·39	0·14	12·22
Others (including castings) . .	0·08	0·08	0·42	—	0·06	0·13	0·07	0·05	0·02	0·97
Total . .	0·63	1·29	2·13	1·48	3·21	2·38	0·80	3·22	0·40	15·55
Pig iron charged hot .	0·62	0·22	0·09	1·03	1·59	0·10	0·16	0·87	0·22	4·90
Pig iron charged cold	0·01	0·25	0·39	0·02	0·13	0·60	0·10	0·65	0·04	2·20
Scrap charged .	0·10	0·96	1·80	0·51	1·64	1·92	0·61	2·04	0·19	9·77
Scrap percentage .	14	67	79	33	49	74	70	57	42	58
1939 *Average capacity in tons:*										
Per furnace .	—	55	59	131	108	47	64	52	44	68
Per plant .		438	382	753	687	400	270	333	218	454
Median capacity in tons:										
Per furnace .	—	—	—	—	—	—	—	—	—	60
Per plant .	—	—	—	—	—	—	—	—	—	358

Scrap percentage is of pig iron plus scrap charged. Calculation of average capacity is indicative only of relative size, district by district, owing to incompleteness of data: this has been made from the returns in *Ryland's Directory* for 1940. Other returns are from the statistics of the British Iron and Steel Federation.

The North-west Coast, like the East Midlands, has a steel output less than its pig-iron output. The gap between pig iron and steel, however, is decreasing: in 1913 and 1929 pig-iron output was three times, but in 1932, 1937, and 1945 twice that of steel. Neither pig iron nor steel output are increasing, the North-west Coast being the only district where steel output in 1945 had not increased over the 1913 level. Nevertheless, it produces more haematite pig than any other district. The surplus haematite pig is sent to acid steel plants all over Britain in much the same way as haematite pig from the North-east Coast. The makers of haematite pig are makers of acid steel to only a very limited extent, the make of acid steel being mainly in Sheffield, Scotland, and South Wales, which themselves make only small quantities of haematite pig.[1] The steel output of the North-west Coast is mostly acid, being made by acid Bessemer plant at Workington in Cumberland and by acid Open Hearth plant at Barrow-in-Furness. Basic Open Hearth steel is also made at Barrow. The greater part of the haematite pig is charged hot into the converter or furnace and, as is the rule in the integrated plants on the orefields, comparatively little scrap is added.

These steel plants located on the orefields thus exhibit comparable features. They produce more pig iron than they require for their steel plant, except in North Lincoln. They thus export their pig to other districts; this is particularly the case with forge and foundry pig and with haematite pig, practically all the basic pig being charged hot into basic steel plant on the same site. Secondly, with few exceptions, the steel plants are closely integrated with blast furnaces on the same site and the blast furnaces are themselves on the same sites as the orefields or are in close proximity to them. Such integration makes for relatively low costs of production of steel *in bulk*, for transport costs are minimized and fuel costs are reduced by using waste gases and by charging pig hot into the steel furnace. The steel plants located on the orefields tend to concentrate on heavy iron and steel products, as will appear later. The steel plants and the individual steel furnaces, moreover, are larger than in the country as a whole, and they thus have the advantage of large-scale operation which heavy standardized products require. Those blast furnaces in these districts which are independent of steelworks make pig designed primarily for forge and foundry work or for steel-making elsewhere. Thirdly, the orefield steel plants use comparatively small quantities of scrap, the scrap percentage being 33 as compared with

Federation envisage an integrated plant at Shotton, with coke ovens, blast furnaces, steelworks, and rolling mills, using imported ore and scrap. The Irlam plant on the banks of the Manchester Canal is already such an integrated plant.

[1] The figures for 1937 were—North-west and North-east Coasts, haematite pig, 1·39 million tons; acid steel, 0·55 million tons; Sheffield, Scotland, and South Wales, haematite pig, 0·43 million tons; acid steel, 1·89 million tons. The returns for 1945 were respectively 0·89, 0·33, 0·18 and 1·03 million tons.

the national average of 54 in 1937 and 40 as compared with 58 in 1949. Let us now turn to the coalfield sites.

South Wales produces as much steel as the North-east Coast, but its pig-iron output is totally inadequate to meet its needs. In 1949 it made 1·20 million tons of pig iron, but 3·22 of steel. The district, therefore, is a large importer of pig iron from the haematite pig districts of the North-west Coast and of the North-east Coast and from the basic pig districts of the nearby continent.[1] For reasons of ease of coastwise shipment the North-west Coast is the largest source. When Scotland was an important blast-furnace district pig iron was brought coastwise from the West of Scotland also, and pig has been imported even from North America. As some of this pig comes in by sea, the coastal location of steel plants in South Wales is as necessary as the coastal location of blast furnaces dependent on imported ore. Larger quantities of scrap than of pig are charged into the furnace; in 1937 67 per cent of the total (pig plus scrap) being scrap.[2] South Wales, in fact, is the largest single market for scrap in Great Britain, and some scrap is imported in addition. The relatively few blast furnaces remaining in South Wales are all associated with steelworks, whether they are on the coast (as the new Margam plant) or (as the new Ebbw Vale plant) on the northern edge of the coalfield. Being in the bituminous or semi-bituminous parts of the coalfield, they are on or near supplies of coke; but they are removed from ore supplies which (apart from locally won haematites) have to be brought in from Northampton or abroad. They are all Open Hearth plants, except the basic Bessemer plant at Ebbw Vale. But the steel-makers independent of blast furnaces are much more numerous and they are mostly located on or near the coast in the tinplate district west of Swansea. They are nearly all equipped to make both acid and basic Open Hearth steel. These are integrated not backwards with blast furnaces, but forwards with rolling-mills and tinplate-mills. The western steelworks, centring on Swansea and Llanelly, without exception make tinplate bars for the tinplate-mills; they have tinplate-mills on the same site or in the near vicinity. The eastern steelworks, although on the coast, are associated with tinplate-mills only in part and they make other rolling-mill products —plates, rails, wire rods. The Ebbw Vale plant is an exception to this, both in site and in type of production. In the latter part of the nineteenth century there were many steelworks in the hills, making steel with the Bessemer converter.[3]

[1] On the prospects of importing pig iron in the future, see the *Report of the British Iron and Steel Federation on the Iron and Steel Industry* (1946), Cmd. 6811, p. 11.

[2] The percentage of pig iron increased after 1937 as a result partly of the integrated Ebbw Vale plant. It was 57 per cent in 1949.

[3] The new plant being constructed on the coastal marshes at Margam, Port Talbot, will be an integrated plant when completed with blast furnaces, Open Hearth furnaces, and a continuous hot strip mill.

Scotland, similarly, has a steel production far in excess of its pig-iron output and the gap was widening progressively between 1913 and 1949. The output of steel has increased, though at a slower rate than in the country as a whole, and the widening of the gap has been due primarily to the decline of pig-iron production in Scotland owing to causes considered earlier. In 1913 output of pig iron had been 1·37 million tons and of steel 1·43, but in 1937 the figures were 0·50 and 1·90 respectively, and in 1949 0·77 and 2·38 respectively. The output both of haematite and of basic pig is insufficient; haematite pig is brought in from the North-west Coast and from the North-east Coast, and basic pig from abroad. In addition scrap is added to the charge, as in South Wales.[1] The output of basic pig is the larger and the increase in steel production has been entirely in basic steel. There is integration of plant backwards to only a limited extent. Of the twenty-eight blast furnaces in 1937 only eight were located on the same sites as steelworks; of the steel plant with a total capacity of 3,595 tons, plant with a capacity of only 650 tons was on the same sites as blast furnaces. Many of the blast-furnace firms make only forge and foundry pig and most are located away from the coast, even though they are almost entirely dependent upon imported ore. The iron industry was inland and not coastal in its origins. An elaborate replanning of Scottish steel production in integrated plants using imported ore is set out in the Report of the British Iron and Steel Federation.[2]

The West Midlands has a steel output in excess of pig-iron output, and a not inconsiderable proportion of the pig made is of forge and foundry grades. Large quantities of scrap, of course, are added, as is appropriate to this district with its innumerable finished iron and steel trades.[3] Nevertheless, there is an export of basic pig from the district, from North Staffordshire to the Shotton plant on Deeside: North Stafford is in this respect orientated away from South Stafford. The steel made in the West Midlands is almost entirely basic Open Hearth and of the four steel plants listed in 1937 all but one are run by firms with blast furnaces making basic pig on the same site or nearby. The greater number of blast furnaces, however, make only forge and foundry grades, as in Scotland, and many make cold blast iron used for special purposes by the finished iron trades. These are only small in size. Most of the blast furnaces and steel-works are in the Black Country, but there is the Shelton plant in North Stafford, and there is a blast furnace at Shifnal in Salop.

The Sheffield district, which includes Rotherham farther down the Don Valley as well as Sheffield itself, makes little pig iron, but is of the same rank as Scotland in production of steel. In Sheffield

[1] The 1949 percentage has increased over the 1939 level, unlike South Wales.
[2] Cmd. 6811, pp. 18–20.
[3] The 1949 percentage was no greater than in 1937.

itself the steel is almost entirely acid, and is of special qualities designed for Sheffield wares. The basic steel is made at Rotherham and Stocksbridge, outside Sheffield, and not in Sheffield itself. The quantity of basic steel produced is greater than that of acid steel, for the latter, required for many small articles, is not needed in large quantities. There is little backwards integration, there being only one plant (at Park Gate) which has both blast furnaces and steel plant on the same site, and this makes basic steel. The Sheffield firms are entirely disassociated from blast furnaces, they buy in haematite pig and they add large quantities of scrap. The percentage of scrap added is now the highest of any district, being 79 per cent in 1949. The Sheffield acid steel plants are integrated forwards with rolling-mills and finished steel manufacture. The average plant in Sheffield itself is much smaller than elsewhere. As Sheffield wares are so small the amount of steel required of a particular composition is not large, and for these products small capacity furnaces may be more economical than furnaces of large capacity.

The steel plants on the coalfields thus exhibit features different from those on the orefields. They make more steel than iron, and for this purpose they import pig from districts within Britain and from abroad. They thus normally feed pig cold rather than hot into the furnace. This is the reverse of the practice in the orefield plants. In addition, the coalfield plants charge large quantities of scrap amounting in 1937 to two-thirds of the total in South Wales and Scotland and to nearly three-quarters of the total in the West Midlands and at Sheffield.[1] Scrap is available in these districts, owing largely to their finishing industries, in greater quantities than in the orefield districts which have finishing industries to a much lesser extent. The coalfield plants are integrated backwards with blast furnaces much less than the orefield plants, and their most common integration is forwards with rolling-mills and finished iron- and steel-mills. Many of the blast furnaces which do exist make only forge and foundry pig intended for wrought and cast iron. Being removed from ore and in large measure from blast furnaces, these coalfield plants may not be able to produce steel as cheaply as the steel plants integrated with blast furnaces on the orefields. In consequence they tend to concentrate their attention on the special steels which are required in smaller quantities and for special purposes, and which need closer collaboration with the consumers of steel. The steelworks located on the coalfields, it is true, do not all exhibit these characteristics, and the proposals of the British Iron and Steel Federation contemplate more integrated plants in the future. The average size of plant on the coalfields is less than on the orefields, partly perhaps because they may be older and less up to date, but partly also because of the different emphasis of steel-making on

[1] The percentages in 1949 were 57, 74, 70 and 79 respectively.

these sites, emphasis being on special steels rather than on standard steels in bulk. These standard steels, the larger plants on the ore-fields are much better fitted to supply.

IV

FINISHED IRON AND STEEL MANUFACTURE

We pass now to the making-up of steel into finished products. Most, if not all, steelworks have a cogging or blooming mill where the ingot is rolled into blooms, billets, or slabs. They frequently, too, handle the bloom or the billet further and make such semi-products as sheet bars or tinplate bars. But not all steelworks themselves roll down their semi-manufactured steel into finished products. Some is sent to re-rollers who do not themselves make steel, and who may not be in the same district.[1] The distinction between the integrated establishments and the pure re-rollers is not simply one of management: it has geographical implications, and it must accordingly be examined as closely as space permits. Why should this distinction between integrated plants and re-rollers exist? The technical factors are significant. First, the integrated plants are well adapted to make large quantities of standard lines such as rails or plates, but they are not as well adapted to make small quantities of special lines. A large works emphasizes economical production, and this is not possible if only small quantities are made, because of the constant changing of rolls necessary for small lots with the loss of time and of productive capacity which this involves. Specialities in

[1] According to the lists in *Ryland's Directory* the proportion of re-rolling plants to rolling plants attached to steel works or to puddling furnaces is two to one. The pure re-rollers are twice as numerous as the integrated plants. But number of plants almost certainly overemphasizes the importance of the re-rollers. It would appear from the statistics of the British Iron and Steel Federation that of the total make of billets, blooms, and slabs in 1937 little more than one-quarter was dispatched from the steel works, and that, even if the entire import of billets, blooms, and slabs be attributed to the re-rollers (a large assumption), these would appear to have handled only two-fifths of the quantities handled by the steel works. For sheet bars and tinplate bars the re-rollers would appear to be relatively more important, 59 per cent of the total make being dispatched from the steel works and (after adding imports to re-rollers) the re-rollers would appear to have handled half as much again as the integrated plants. Of the 33·2 per cent of the total output of blooms, billets, slabs, sheet and tinplate bars dispatched from steel works in 1936, 15·0 per cent went to allied or subsidiary works on other sites and 18·2 per cent to independent works. Using the same data, S. R. Dennison remarks that the low proportion of the make of sheet and tinplate bars used further in the plant making them 'is highly misleading, for in the tinplate section a great part of the output is transferred to other plants of the concerns which produce it' (S. R. Dennison, 'Vertical Integration and the Iron and Steel Industry', *Economic Journal*, vol. XLIX (1939), p. 258). Richard Thomas & Company, for example, have many tinplate works on sites other than their steelworks, and there are steelworks in the Swansea-Llanelly district which were set up by tinplate-makers to make tinplate bar for them. In these instances the tinplate bar is recorded as being dispatched from the steel works. While these firms may be *economically* integrated, they are not *geographically* integrated, and from the geographical point of view the distinction therefore remains valid.

iron and steel, as in most other industries, are the province of the relatively small plant. It is true that the costs of production of a small plant may be higher than those of a large plant, but a speciality can command a higher price and higher costs are not necessarily a deterrent. Second, there is the question of fuel economy. If finished products could be made directly from the hot state their manufacture in an integrated plant would be greatly encouraged and their manufacture by a re-rolling plant, where reheating is inevitable, correspondingly discouraged. But, even in an integrated plant, reheating is often unavoidable. From the point of view of fuel economy there is not the same advantage in integrating steel-making with finished products as in integrating steel-making with iron smelting.

If the market for the finished product is close at hand to the integrated works, then, other things being equal, the finished article might well be made on the site of the steelworks. Thus, ships' plates tend to be manufactured by steelworks in shipbuilding districts; but ships' plates have the advantage of being standard lines made in large quantities and thus suitable to an integrated plant. If the market happens to be in another district the relative transport costs of semi-products and of finished products enter into the situation. It often happens that, owing to the design of railway classifications, semi-products cost less to transport than finished products over identical distances. 'Hence,' as D. L. Burn speculates, 'it might be cheaper to dispatch semis to a works near the final consumer and to re-roll at the market, than to re-roll where the semi-product was made and carry the finished product to the market.'[1] The existence of re-rollers in areas of consumption, that is, areas having engineering and metal-using industries, is an example of the general rule in the location of British industry that the more the finished product diverges from the initial materials the more does it tend to be located at its market. Engineering, however, expresses this rather more clearly than re-rolling. The location of re-rollers in close proximity to their markets is technically desirable in respect of those making products for engineering industries. Many re-rollers, in fact, are also engineers: they may be engineers who have taken up re-rolling, and perhaps steel-making as well, to get the specifications and qualities they require, or they may be re-rollers who have become engineers to dispose of their products. There are instances also of blast-furnace masters who are steel-makers and engineers. Many re-rollers, however, have no organic relation to engineering firms, but find it convenient to be in close proximity to them. Now, engineering shops are widely dispersed, but, as will appear in the next chapter, they are largely focused on the coalfields where they originally developed in the first phase of the coke-iron industry when they employed malleable and cast iron. Hence the concentration of

[1] Burn, op. cit., p. 265

re-rollers also on the coalfields which, as we have seen, have now a steady output of both pig iron and steel. The initial stages of the industry have tended to abandon the coalfields, iron smelting to a greater extent than steel-making, but the re-rollers, except those affected by the conditions discussed in the next paragraph, have tended to remain.[1]

The geographical separation of re-rollers and of integrated plants is further emphasized in Britain by the structure of British foreign trade in iron and steel. This consists in large measure of the import of semi-products (blooms, billets, slabs, sheet and tinplate bars) and of the export of finished products (rails, galvanized sheets, tinplate, tubes, and innumerable other articles), some of which are made in part out of the imported semi-products. The imported semi-products have tended, for reasons discussed *in extenso* by Burn, to be cheaper than British semi-products. For obvious reasons they have tended to be used primarily by the re-rollers. For both receipt of imported material and for export of finished product, re-rollers involved in this trade are located most conveniently on the coast.[2] In 1949 the Bristol Channel ports took 64 per cent of the pig iron import and 24 per cent of the import of blooms, billets and slabs: other west coast ports took a third of the pig iron and nearly a third of the blooms. They went, therefore, not so much to eastern England, where the Jurassic belt and Yorkshire together produced two-thirds of the pig iron and over half of the steel, as to western Britain, with only one-third of the pig iron and less than half of the steel. Western Britain has many more coastal or sub-coastal metal-using districts than eastern Britain, and shipping services are such (in reference to the export trade) as to favour west coast rather than east coast ports, with the exception of London.

After this discussion of the distinction between integrated plants and re-rollers and of the geographical implications of this distinction, let us review in general terms the problem of the integration of the British iron and steel industry. The problem is not the same in a

[1] This distinction between integrated plants and re-rollers may have other than economic and geographical implications. In the debate on the iron and steel industry in the House of Commons on 27 and 28 May 1946, the Minister of Supply declared that public ownership would include integrated plants, but that finishing processes carried on in separate works would be considered separately 'section by section and firm by firm'. Speaker after speaker from both sides of the House warned the Minister of the practical difficulties of drawing a line (*Hansard*, vol. CCCCXXIII (1945–6)). The schedule of nationalized firms registers this distinction.

[2] This was emphasized by the evidence of the Steel Re-rollers' Association before the Balfour Committee on Industry and Trade in 1924. 'Is your point this, that unless you are allowed free import, that trade could not be done at all?—Certainly. There is a point there I should like to enlarge upon. In 1901 the sheet business was done almost entirely in the Midlands; then a few years later it began moving to the coast; now the business is entirely established on the coast. If tax is put on imported sheet bars and billets, I think you may be dead certain that it will move again and it will move to the Continent, probably Belgium' (*Minutes of Evidence*, vol. 1, p. 86, Q. 1643).

geographical as in an economic sense, for geographical integration implies the development of all processes on the same site, whereas economic integration implies simply concentration under single management whether on the same site or not. Of the causes of economic integration considered by S. R. Dennison, only one relates to geographical integration.[1] Integration on the same site is of advantage if it leads to fuel economy and if it eliminates transport and handling. The feeding into the steel plant of pig iron hot from the blast furnace and of the steel ingot hot into the cogging-mill both permit fuel economy, avoiding reheating and permitting the utilization of waste heat and gases:[2] a steel plant almost invariably has a cogging-mill, and blast furnaces and steel plant are associated on the same site as often as they occur on separate sites. The dis-association of blast furnaces and of steelworks, however, is sufficiently frequent to demand examination. On close examination it will be found that there is a very great difference in degree of integration according to the type of pig and steel made. Those blast furnaces producing only forge and foundry pig, of course, are entirely removed from steelworks. Those making Bessemer steel, whether acid or basic, are wholly integrated plants. Those making Open Hearth steel include both integrated and non-integrated plants, but there is a difference in relative frequency according to whether acid or basic steel is made. Of the pig used in basic Open Hearth steel-making, three-quarters is produced on the same site and is mostly fed hot into the furnace, but of the pig used in acid Open Hearth steel-making only one-sixth is produced on the same site, and even that is fed cold into the furnace. Acid Open Hearth plants also feed more scrap.[3] Integration is thus the rule in basic Open Hearth, as well as in acid and basic Bessemer; it is only in acid Open Hearth

[1] Dennison, *Economic Journal*, vol. XLIX (1939), pp. 244–58.

[2] A factor of no small importance in the costs of the industry is the utilization of waste gases. The *Report of the Departmental Committee on Gas Supplies in the West of Scotland* asserts that the utilization of surplus gas may make a difference of as much as nine to ten shillings per ton in the cost of pig iron. These waste gases may be utilized in an integrated plant, but they may also be utilized by other plants and by other industries (and perhaps by domestic consumption) if the gas be fed into a gas grid such as exists in the Sheffield district, and on a minor scale on the North-east Coast and West Cumberland, and such as has been advocated for the West of Scotland. A gas grid implies considerable density of industry and of population within the area covered, and is without doubt more likely of success in a closely occupied industrial district such as Sheffield than in a blast furnace district on ore-fields in a rural area such as Northampton In the former instance the successful use of waste gas by other industrial consumers might compensate to no small degree for increase in costs due to lack of integration and to transport of material; in the latter instance integration would provide the only satisfactory outlet for waste gas. The *Report* of the Committee of Enquiry on the Gas Industry (1945), Cmd. 6699, placed the quantities of coke-oven gas bought by gas undertakings at no less than 12 per cent, the largest quantities being at Sheffield, both actually and relative to total gas consumption. See Table XXXVII.

[3] The data are drawn from the returns of the British Iron and Steel Federation for 1937, p. 14.

TABLE XLIV

District Percentages of Numbers Employed in Iron and Steel Production 1935 Census of Production

	In percentages of number employed in the United Kingdom, 1935							
	Lancs Ches.	West Riding	North-east Coast	West Mid^f lands	East Mid-lands	Wales	Cent. Scot-land	Grtr Lon-don
Area No.	2	3	4	5	6	12–13	14–15	1
Blast furnaces .	9	2	26	6	22	7	9	—
Steelworks and rolling mills .	9	31	14	11	1*	18	12†	—
Foundries .	10	8	6	26	13	3	18	6
Tinplate . .	—	—	—	—	—	90‖	—	—
Hardware, Hollow-ware, etc. . .	8	5	2	43	3	3‖	3‡	26
Chain, nail, screw, etc.	8	10	1	62	2	1	6	7
Tube	—	—	—	60	8*	—	—	3
Wire	32	23	7	14	—	2‖	9	9
Implements, tools .	3	57	—	28	—	—	2	8
Cutlery . . .	—	77	—	—	—	—	—	16
Metal smallwares .	—	—	—	83	9	—	—	2
Total . .	8	17	6	30	5	10	9	8

Calculated from the 1935 Census of Production. Area 5 is not the area described as the West Midlands in the *Report* on the Census, but it is the area which is geographically the industrial West Midlands. Remainder is in districts not listed in the table.

* Includes also area 7. † Includes also area 16. ‡ Includes also area 17. ‖ Area 12 alone.

that separation of blast furnaces and steelworks is at all frequent. The acid Open Hearth plants happen to be focused chiefly in the Sheffield district, in Scotland, and in South Wales, districts which have themselves few blast furnaces for reasons discussed earlier. In these districts steel-making is integrated forwards with finished steel products and not backwards with blast furnaces. The degree of integration is thus not only a test of efficiency: it is also a reflex of process and of geographical distribution. It is possible, of course, to argue that those sites which do not permit integration are relatively inefficient, at any rate for the production of standard lines, unless there are compensatory economies in the use of waste gases elsewhere than in integrated plants. Writing of the integration of tinplate-mills with steelworks, Prof. J. H. Jones observed some thirty years ago, 'It is by no means certain that the control of the two stages was a real economy in all cases. It is true that the cost of marketing was eliminated, and that in most cases transport charges were reduced.'

TABLE XLV

Production of Certain Finished Steel Products by Districts, 1949.

In thousand tons

<table>
<tr><th></th><th>Plates</th><th>Other Heavy</th><th>Light Rolled</th><th>Sheets</th><th>Tubes</th><th>Wire</th><th>Wheels Axles</th><th>Forg-ings</th><th>Cast-ings</th></tr>
<tr><td>East Midlands</td><td>—</td><td>23</td><td>405</td><td rowspan="2">407</td><td>306</td><td>7</td><td>—</td><td>32</td><td>18</td></tr>
<tr><td>Lancashire—North Wales</td><td>43</td><td>35</td><td>537</td><td>—</td><td>337</td><td>97</td><td>23</td><td>13</td></tr>
<tr><td>Yorkshire</td><td>27</td><td>160</td><td>1,040</td><td>29</td><td>13</td><td>211</td><td>131</td><td>149</td><td>66</td></tr>
<tr><td>Lincolnshire</td><td>354</td><td>175</td><td>96</td><td>—</td><td>—</td><td>—</td><td>—</td><td>13</td><td>4</td></tr>
<tr><td>North-east Coast</td><td>750</td><td>990</td><td>550</td><td>79</td><td>44</td><td>36</td><td>2</td><td>32</td><td>43</td></tr>
<tr><td>Scotland</td><td>633</td><td>418</td><td>289</td><td>74</td><td>178</td><td>24</td><td>3</td><td>47</td><td>46</td></tr>
<tr><td>West Midlands</td><td>62</td><td>389</td><td>595</td><td>89</td><td>363</td><td>58</td><td>—</td><td>173</td><td>31</td></tr>
<tr><td>South Wales</td><td>170</td><td>129</td><td>674</td><td>783</td><td>85</td><td>119</td><td>10</td><td>5</td><td>12</td></tr>
<tr><td>North-west Coast</td><td>—</td><td>97</td><td>53</td><td>—</td><td>—</td><td>—</td><td>—</td><td>1</td><td>3</td></tr>
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From the *Statistical Year Book for 1949*, British Iron and Steel Federation. The description 'wire' appears to refer to wire rod rather than to finished wire manufactures.

But it happened that 'the steelworks owned by a tinplate manufacturer, while being determined by the number of tin-mills under his control, was generally smaller than those of steel-makers producing for the general market. And the cost of manufacture of bars was therefore higher. It is probably true that in some cases the cost was at least as high as the market price of bars.'[1]

In scarcely any instance, however, does integration imply a self-contained plant with no surplus to sell and with no deficiency to supplement at every stage of production. The existence of surpluses may be seen clearly from the list of products for sale issued by almost every integrated plant. It is equally clear if any attempt be made to equate blast-furnace capacity with steelworks capacity on particular sites; in some establishments blast-furnace capacity exceeds steelworks capacity and pig iron is sold, in others, steelworks capacity exceeds blast-furnace capacity and pig iron is bought in. Dennison has quoted returns from three firms of different types to prove the point beyond question. The reasons are largely technical. Each stage of production has its own optimum size and the optimum of one is rarely equivalent to the optimum of another: 'every integrated concern has to face the problem of compromising between optimum

[1] J. H. Jones, *The Tinplate Industry* (1914), p. 170.

technical efficiency at every stage and a balanced flow of output'.[1]

Let us now examine the geographical distribution of the several forms of finished steel production. I will begin with the heavier branches—rails, plates, and girders.

In Great Britain rails are made invariably by integrated plants, the re-rollers having no share whatever in the trade.[2] It will be observed from Table XLVI that the most important districts are the North-east Coast, South Wales, and the Rest, which in this instance means the North-west Coast, Workington and Barrow-in-Furness. The markets for rails are partly home and partly export, and these have varied in relative importance from time to time. British railways themselves provided a large market during the development of the British railway system in the second and third quarters of the nineteenth century,[3] and, when the British home demand began to fall away, railway building abroad was developing rapidly. Subsequently the volume of rail exports tended to decline owing to the competition of other producing countries and to the decline in the volume of railway construction. Exports of railway iron and steel (including sleepers, fishplates, wheels, tyres, and axles as well as rails) had been 0·7 million tons in 1913, but had fallen to 0·2 in 1937, representing 30 per cent of output in the latter year. In the early stages when British railways provided the chief market rail-mills were widely distributed over the country, but with the development of export (together with the coastal migration of steel-making) the rail-mills came to be focused on the coast. Rail-making plants in the interior, John Brown's at Sheffield, for example, turned over to other products. Although the export trade has declined in both actual and relative importance since 1929, rail-making still remains in coastal plants, although some of these, the Barrow Haematite Steel Company, for example, have now developed a more diversified production. The rail plant in South Wales is at Port Talbot, on the coast: the old hill plants on the north-eastern margin of the coalfield had been primarily rail-making plants. Of the firms listed in *Ryland's Directory* as making railway rails, three-quarters have plants on the coast or with access to ocean-going vessels. It is not without significance that no British railway company now makes its own rails, partly perhaps because its own consumption would be insufficient to require the whole production of a rail-mill operated at its optimum efficiency.

[1] Dennison, *Economic Journal*, vol. XLIX (1939), p. 253. See the very interesting maps of blast-furnace and of steelworks capacity published in colour by the Ordnance Survey, drawn by the Ministry of Town and Country Planning, and reproduced as figs. 45–7.

[2] Rails can be made from all four types of steel. At first steel rails were all made by the acid Bessemer process, and this remains one of the most satisfactory uses of acid Bessemer steel, but engineers now prefer Open Hearth steels which, though more expensive, are held to give better results. Basic Bessemer steel is rarely employed in Great Britain except for tramway rails.

[3] Until the 'seventies rails were made of malleable iron.

TABLE XLVI

Regional Distribution of Finished Iron and Steel Production, 1924

	In percentages of the United Kingdom						In M.T.
	Shef-field	North-east Coast	West Mid-lands	South Wales	Scot-land	Rest	United King-dom
Rails	10	36	2	23	3	26	0·60
Plates .	4	36	3	10	45	2	1·65
Sections, angles, etc.	1	35	17	4	37	6	0·87
Girders, joists, beams .	—	51	11	—	17	21	0·39
Rounds, squares, flats, etc.	18	9	31	7	18	17	0·87
Wire rods . .	23	10	2	21	—	44	0·26

Calculated from the returns of the National Federation of Iron and Steel Manufacturers for 1924. Similar returns are not available for a later date

The plant at Crewe of the London Midland and Scottish Railway closed down in 1932 when Workington and Barrow purchased its quota.

The making of plates is focused in steelworks and ironworks, two-thirds of the plants listed in *Ryland's Directory* as having plate-mills being also steelworks or ironworks having puddling furnaces, and a few of the remainder belong to firms with a steelworks elsewhere. It is, like rail-making, a heavy branch of the industry and is equally closely associated with the primary manufacture of iron or steel. It is not a common re-rolling trade and the few re-rollers that are in the plate trade invariably make only light plates.[1] The output of steel plates is rather more concentrated than the number of firms making them. It may be inferred that away from the main districts plates are made in relatively small quantities or of relatively light weights. The heavy plate-makers are focused in the West of Scotland and on the North-east Coast, which between them handled over 80 per cent of the total volume of output in 1924. South Wales and North Lincoln have also a not inconsiderable production of heavy plates, the latter having probably entered the trade since 1924. South Wales plates, like its rails, are made in the eastern large-scale coastal steelworks which do not produce tinplate bars for the tinplate trade. The steelworks tied up with the tinplate trade are smaller and lie farther west, centring on the valleys leading to Swansea and Llanelly. The plate-making districts are coastal or sub-coastal,

[1] Bessemer steel was relatively early replaced by Open Hearth steel on account of its greater reliability, but it was long before basic Open Hearth steel was accepted by shipbuilders and constructional engineers equally with acid Open Hearth steel. To-day, the greater number of the plate mills are attached to steelworks which make both acid and basic Open Hearth steel, some are attached to steelworks which make basic steel alone, but none to works which make acid steel alone.

though not all plants, especially in the West of Scotland, are on the coast. The coastal location gives access to the markets for heavy plates which are primarily the shipbuilding and repairing yards, the largest of which are in the West of Scotland and on the North-east Coast. Export abroad takes a relatively small proportion of production; this, therefore, is not a powerful factor in determining coastal site except in a restricted number of cases. The inland mills, with very few exceptions, make light plates which are required for uses other than ship work, and whose market is in inland engineering rather than in coastal shipbuilding districts.

Girders, joists, and beams constitute a third group of heavy iron and steel products. Of those firms listed in *Ryland's Directory* as girder-makers, almost all are steel-makers or iron-makers, and the only re-rollers involved in the trade make colliery arches.[1] Export abroad constitutes a relatively small proportion of output; although it is probable that the percentage exported was previously higher, it was 21 per cent in 1929 and only 4 per cent in 1937. A coastal site is necessary to-day only for that part of the production destined for export and for ship work. The making of girders, joists, and beams is, in fact, less sharply focused on coastal districts than the output of rails or plates. In 1924, when the percentage of export was higher, the North-east Coast produced half the total output and the other districts were Scotland, the West Midlands, and scattered plants at Scunthorpe, Barrow, Irlam, and Rotherham. Many of these are inland districts.

From these heavy iron and steel products thus closely associated with primary steel manufacture, we turn now to lighter finished and semi-finished iron and steel. Let us consider, first, the sheet rollers. Of some 402 sheet-mills listed in *Ryland's Directory*,[2] three-tenths (121) are on the same site as steelworks and seven-tenths (281) are on other sites, although, of course, some of these are on sites adjacent to steelworks or belong to firms which themselves own or are associated with steelworks elsewhere. Even if the number of sheet-mills (84) belonging to firms with steelworks elsewhere be subtracted from this total, the pure re-rollers remain equally as important from the standpoint of *economic* integration. From the standpoint of *geographical* integration on the same site, the re-rollers are more than twice as important as the steelworks.[3] The

[1] The steel-makers are chiefly those producing basic Open Hearth alone and all have some basic plant. It would thus appear that the greater part of this class of constructional material is of basic Open Hearth steel. There is an increasing demand for girders for steel-framed buildings; it is a new use and there is not the same objection to basic steel on the part of the user.

[2] These are the number of mills. There may be up to forty-six on a single site.

[3] The steel works that are sheet rollers make both acid and basic steel and some make basic steel alone; only the Sheffield firms make acid steel alone. Most sheets, in fact, are rolled from basic sheet bars, acid sheet bars being employed only on special qualities (H. J. Skelton, *Economics of Iron and Steel* (1924), p. 302).

geographical distribution of the sheet-mills cannot be analysed satisfactorily in their total sense, however, for there are profound differences both in distribution and in scale of operation between those which make galvanized sheets and those which do not. The distinction between these is made in the lower half of Table XLVII. The sheet rollers which do not make galvanized sheets, though more numerous, operate as sheet rollers on a smaller scale,[1] having only 2·8 sheet-mills per works as compared with the 11 8 sheet-mills per works of the galvanizers, though not necessarily the whole of these sheet-mills are on galvanized sheets. The galvanizers, further, have a more circumscribed distribution, being limited to certain areas presenting especially favourable conditions, and the non-galvanizers, though exhibiting concentrations, are more widely dispersed. The West Midlands and Sheffield–Rotherham have each a third of the sheet-mills belonging to the non-galvanizers and South Wales and Scotland have each a tenth. These districts are the older coalfield sites which had the greater part of the finished iron industry prior to the development of Bessemer steel: sheet rolling is one of the finished or semi-finished branches they have retained. The main blast-furnace districts, the Jurassic belt and the North-west Coast, in contrast, have scarcely any sheet-rolling mills at all.

The distribution of the galvanized sheet rollers is governed by quite different conditions. A large proportion of the output is exported, being 84 per cent in 1929 and 65 per cent in 1937.[2] The requirements of the export trade do, in fact, dominate their location. When made of wrought iron, galvanized sheets were rolled in Staffordshire, but with the development of an export trade in bulk towards the end of the nineteenth century and its progressive multiplication at ten-year intervals up to 1913,[3] there developed a migration to the coast on the part of existing Staffordshire galvanizers. Migration was due in part to save transport costs, for railway rates on finished galvanized sheets are higher than on the semi-product of sheet bars, from which the sheets are rolled, and in part because a coastal site offered still more pronounced advantages to those re-rollers employing imported basic sheet bar. They migrated to the west rather than to the east coast, for established liner services, particularly those of Liverpool, were already developed to precisely those markets in the East and in the Dominions which took most of the galvanized sheets for roofing and farm-building material. South Wales and Lancashire–Cheshire (including North Wales) had 81

[1] Very frequently these have other rolling mills as well. Of the thirty-nine rolling mills of the non-galvanizers, eighteen are sheet rollers only and twenty-one have other rolling mills as well. The average number of sheet mills of these specialist sheet rollers is higher, being 4·5 per works.

[2] It was declared in 1924 that 85 per cent of the output of the whole sheet trade was exported (Balfour Committee on Industry and Trade, *Minutes of Evidence*, vol. I, p. 86).

[3] Exports, in million tons, were 0·17 in 1893, 0·35 in 1903, and 0·76 in 1913.

per cent of the galvanized sheet-mills in the United Kingdom in 1939. Most, though not all, of these sheet-mills are on the coast, often with wharves of their own, so that lighters can load the finished sheets directly into the liner's hold. Practically all the establishments on Deeside, at Ellesmere Port, or at Widnes, migrated from Staffordshire specifically because of an export trade already developed prior to the time of migration. Unlike South Wales, these estuaries had no previously developed trade of a similar kind, and they are not on the coalfields of Lancashire or of North Wales. Migration was all the more necessary as competition in the business meant production on small margins of profit and every conceivable saving of costs was necessary. It is, no doubt, for this reason also that the galvanizers operate on a relatively large scale in order to obtain the advantages of large-scale mechanized operation. In addition to South Wales and Deeside–Merseyside, the North-east Coast also has galvanized sheet-mills. Each of these districts makes basic steel, but only the North-east Coast is in the Jurassic belt on or close to the site of orefields. Basic steel-making in South Wales and in Deeside–Merseyside is dependent on a long haul from Northampton and on imported foreign ores, or it is dependent on basic pig from blast furnace districts elsewhere in Britain and abroad.

The bar rollers display characteristics comparable to the non-galvanizers among the sheet rollers in respect of degree of integration with steelworks and in respect of geographical distribution. From the standpoint of integration on the same site the re-rollers are equally as important as the integrated plants at ironworks or steelworks.[1] The number of bar-mills at any one works, however, is small (2·1), and, even in the case of the re-rollers, most have other rolling equipment in addition. There are, it is true, some differences in detail with the non-galvanized sheet rollers, but these need not concern us here. The similarity in geographical distribution is striking, as Table XLVII shows. Sheffield[2] and the West Midlands again stand out as areas of primary concentration, South Wales and Scotland again as areas of secondary concentration, but, in the case of the bar-mills, Lancashire is added. While the galvanized sheet rollers in Lancashire–Cheshire are grouped around the coastal estuaries, the bar rollers of Lancashire, are in the industrial towns on, or associated with, the coalfield. All these primary and secondary areas are coalfields and the orefields of the Jurassic belt and of the North-west Coast have no more than 7 per cent of the total number

[1] The figures are for number of mills—fifty-eight attached to steel works, twenty-eight to iron works, and seventy-seven to re-rollers. Bar-rolling is done elsewhere in addition to these, but the number of bar mills is not listed in *Ryland's Directory* for these other establishments.

[2] The importance of Sheffield in respect of percentage of output may be over-emphasized by these percentages based on number of mills, for the Sheffield bar mills handle bars rather smaller than the average

of bar-mills. The sites of finished iron industries in the early part of the nineteenth century have retained bar as well as sheet rolling.

Wire rods form another semi-product of a similar nature. They are the product of rolling, the wire being subsequently drawn from the rod in a different mill. The re-rollers are more numerous than the steelworks and ironworks, but it does not necessarily follow, of course, that they make the greater part of the output of wire rods. The primary centres are Lancashire (Warrington–Irlam–Manchester), Sheffield, and South Wales, but there are also isolated plants on the North-east Coast and in the West Midlands. Basic steel, whether Thomas or Open Hearth, is as suitable for wire rods as for tube strip. The wire-rod makers are widely dispersed and have the same type of location as the bar-mills and the non-galvanized sheet-mills.

Finally, let us consider the finished products (in addition to the direct products of rolling-mills, already examined) usually made on premises other than rolling mills. They include tinplates, wire, tubes, foundry castings, hardware and hollow-ware, metal smallwares, tools, and cutlery. Engineering products will be considered later in a subsequent chapter.

Table XLVIII sets out the relative importance of these finished trades in respect of metal consumed and number employed. Corresponding data for blast-furnace production and for steelworks and rolling-mills have been added to the table for comparative purposes. It will at once be observed that the weight of metal handled per person employed is very much higher in blast furnaces and in steelworks and rolling-mills than in any of the finished trades. The finished trades are arranged in the table in order in respect of the ratio between weight of metal and numbers employed; those at the bottom of the table use almost insignificant quantities of material. This lesser weight of material per person employed in the finished trades has a profound significance in respect of their location. It has been pointed out above that the heavier products (rails, plates, girders) are more closely integrated with the steelworks than the lighter semi-products (sheets, bars, wire rods). The same kind of distinction holds good within the finished iron trades now under consideration. Those with a higher weight of metal per person employed (tinplate, tubes, wire) are sometimes associated with steelworks and rolling-mills, and will probably be more closely associated in the future, but those with a lower weight of metal per person employed are rarely thus associated.[1] These trades, therefore, are increasingly free

[1] It is significant that the Import Duties Advisory Committee's *Report on the Present Position and Future Development of the Iron and Steel Industry* (1937) drew a line at precisely this point between those branches of production which it decided to consider and those which it decided to ignore. Tinplate, wire, and tubes, were included, but the rest of the trades in Table XLVIII were omitted from consideration: 'their problems are wholly different from . . . those of the heavier branches' (p. 7)

TABLE XLVIII

Materials Used and Numbers Employed by Finished Iron and Steel Industries, 1935

	In thousand tons							In numbers	In tons
	Steel billets, etc	Bars and rods	Plates, sheets	Hoop and strip	Wire	Other iron and steel	Total metal	Number employed	Metals used per person employed
Tinplate	—	858·3	—	—	—	—	869·1	21,985	39·5
Tube	342·3	19·2	—	395·6	—	—	757·1	28,387	26·7
Wire	106·6	393·5	—	—	78·5	—	634·2	23,427	27·1
Chain, nail, screw	—	433·5	—	—	117·5	166·5	732·0	56,783	12·9
Tin boxes	—	—	187·5	—	—	—	187·8	20,557	9·1
Hardware, hollow-ware, etc	—	—	349·5	—	—	4·3	376·0	77,221	4·9
Tool, implement	—	—	—	—	—	82·4	82·4	25,508	3·2
Needle, pin, etc.	—	—	—	—	5·5	4·7	10·2	12,462	0·8
Cutlery	—	—	—	—	—	4·0	4·0‡	10,809	0·4
Blast furnaces	—	—	—	—	—	—	6,488·6*	15,815	410·3*
Steel works and rolling mills	—	—	—	—	—	—	12,296·6	135,274	90·9
Foundries	2,091·7†	—	—	—	—	—	2,091·7	109,643	19·1

* Output of pig iron and ferro-alloys.
† Pig iron, 1,446·8; scrap, 644·9.
‡ Excluding blanks.

Abstracted or calculated from the 1935 Census of Production.

to be located elsewhere than in centres of primary iron and steel production. Some make products direct for consumption, but others (such as nuts and bolts) for consumption by engineering industries. The second type tends to be located in the vicinity of engineering establishments, but the first type, particularly when the weight of material handled is very low, has a wide variety of localities open to it. Some members of this first type, in fact, are very widely dispersed, but others are focused into particular localities, such as cutlery into the Sheffield district, in order to take advantage of the skilled labour available in a particular locality. To some extent this is a residual of handicraft manufacture when skill was all-important, and this concentration may become less complete as production becomes more and more mechanized, but it is still of great significance, particularly in the older established trades with a long tradition of craftsmanship and whose size is insufficient to permit many scattered centres.

TABLE XLIX

Distribution of Tinplate Mills

	Percentage of number of works				Percentage of number of mills		
	1850	1891	1905	1939	1891	1905	1939
Stafford and Worcester	26	6	4	1½	3	3	2
Monmouth and Gloucester	40	18	17	14	20	13	13
Glamorgan	23	52	55	66	53	58	65
Carmarthen	9	20	22	17	23	24	19
Others	2	4	2	1½	1	2	1
	100	100	100	100	100	100	100

The 1850, 1891, and 1905 returns are from J. H. Jones, *The Tinplate Industry* (1914). The 1939 returns have been abstracted from *Ryland's Directory* for 1940, which, published in January 1940, presumably refers to conditions in 1939.

Tinplate-making in[1] Great Britain has long been a highly localized industry. Like galvanized sheets, tinplates were once made of wrought iron and were then manufactured in South Wales and in the Black Country along with other articles in the iron forges. As steel replaced iron the industry became concentrated in South Wales as a specialist trade. Thus, while Staffordshire and Worcestershire had 26 per cent of the number of tinplate works in 1850, they had only 6 per cent in 1891. The major regional shifts in location were accomplished between these dates, as Table XLIX shows. There are now few tinplate-mills removed from South Wales, and those are

[1] For a technical account of tinplate-making, see W. E. Hoare and E. S. Hedges, *Tinplate* (1945).

controlled by South Wales tinplate firms.[1] When tinplate was made of iron, tinplate-makers and iron-makers were synonymous. With the substitution of steel, steel-making and tinplate-making became separated, but, when Prof. J. H. Jones wrote in 1914, vertical integration between steel and tinplate was in active progress. Of the South Wales tinplate-mills in 1939, 23·7 per cent were on the same site as steelworks, 37·5 per cent were owned by firms having steelworks on another site, and of the rest about half were associated financially more or less closely with steelworks, contracting to take the whole or part of their tinplate bars from them. Only one-fifth or thereabouts of the tinplate-mills belong to re-rollers entirely independent of South Wales steelworks. These independent re-rollers were responsible for the greater part of the import of tinplate bar from the Continent, but the re-rollers associated with steelworks also imported some tinplate bar, and in the midst of the Great Depression even the steel producers themselves employed imported bar.[2] Whether home-produced or imported bar is used has depended largely on the degree of the price difference between them. Although imports of tinplate bar through South Wales ports increased to nearly one-third of the total bar used in 1931, there have been only negligible imports since the Import Duties Act of 1932. The distinction between tinplate-mills on the same site as steelworks and tinplate-mills removed from steelworks is significant also in scale of operation. The integrated plants have an average of 14·4 tinplate-mills per plant; but the non-integrated of only 6·1 mills per plant, and this differs scarcely at all whether the re-rolling plant is owned by or is independent of the firms owning steelworks on other sites.[3] The average plant is thus, except those integrated with steelworks, of medium or small size (the average employment per mill at the beginning of this century being 48), and output is consequently comparatively easily adjusted to the state of trade.[4]

The tinplate-mills are strung along the valleys of the western part of the coalfield and are concentrated at the seaward ends of these valleys where the steelworks are located. There is a secondary group in the valleys converging on Newport at the eastern end of the coalfield; Ebbw Vale is included in this group. Tinplate-mills are thus away from the main coal-mining valleys and are established in districts where, at the time of mill construction when coal-mining was also actively expanding, labour was available without severe

[1] That farthest removed is at Mold, in North Wales. It is controlled by Richard Thomas & Company, it can obtain its basic steel locally, and in 1914 it was making tinplates for packing cotton goods.

[2] *An Industrial Survey of South Wales* (1932), p. 63.

[3] The most common (46 per cent of instances) number of mills per works is 4 and multiples of 4, and the next most common (28 per cent of instances) 3 and multiples of 3. In the integrated plants all instances except one are multiples of 5 or of 4.

[4] The point is developed by J. H. Jones, op. cit.

competition from the coal-mines. Rural dispersal was necessary also on account of the large quantities of clean water used in the course of manufacture, and the most advantageous site for this purpose was to be the first plant downstream. In the early period the use of water-power for driving machinery also necessitated a rural valley site.[1] Access to stream water is no longer imperative as reservoir water is now often available, but it is more costly than water drawn from a river or canal. These valleys, whether in the west opening out into Swansea and Carmarthen Bays or in the east behind Newport, also had access to port facilities.[2] The newer sites have tended to be on the coast.[3] The Swansea district had a copper smelting industry from the beginning of the eighteenth century, and this implied close contact with the tin- and copper-mines of Cornwall. This was, no doubt, also a contributory factor to the localization of the industry near to the coast in the western part of the coalfield. No substantial transport costs are involved, however, for in producing a box of tinplates (112 sheets) with a net weight of 108 lb. no more than 2 lb. of tin are employed.[4] In so far as contact with Cornwall was effective in fixing tinplate-making, it was a matter of 'cultural contact' rather than economic advantage. Availability of labour and of water, however, must be accompanied by availability of coal, which is used in substantial quantities owing to the several reheatings which the process of tinning requires, and which is employed, relative to the weight of material handled, in larger quantities than in other finished steel trades.[5] The tinplate industry, therefore, must be located on, or in close proximity to, a coalfield. When tinplates were made of iron, the eastern part of the coalfield, the main seat of the iron industry, had the initial advantage, but the western part of the coalfield in time surpassed the eastern part. Even as early as 1874 the eastern group made less than one-eighth of the total output.[6] The mills of the eastern group then tended to have the older equipment and to operate less efficiently. In 1895 they had a greater percentage of unemployment than the western mills, the percentages being 29 in Carmarthen, 42 in Glamorgan, and 53 in Monmouth and Gloucester. The greater development of the west was confirmed by the establishment of coastal steelworks[7] using imported pig (shipped coastwise) in Siemens Open Hearth steel-making and by

[1] In 1886, 46 out of 346 mills, and even in 1914 two or three mills, were still employing water-power (J. H. Jones, op. cit., pp. 56 and 124).

[2] Burn, op. cit., pp. 234–5.

[3] H. C. Darby, 'Tinplate Migration in the Vale of Neath', *Geographical Teacher*, vol. xv (1929), pp. 30–5.

[4] Skelton, op. cit., p. 328. According to the 1935 Census of Production, 858,000 tons of tinplate bars and 10,000 tons of tin were employed.

[5] Steel bars require heating for rolling into sheets, the sheets require heating twice for annealing.

[6] J. H. Jones, op. cit., p. 33.

[7] D. T. Williams, *The Economic Development of Swansea and of the Swansea District* (1940), pp. 94–126.

the import of foreign semi-products which later developed. It is likely that the industry will remain focused in the western part of the coalfield. The existing continuous sheet strip plant at Ebbw Vale is to be supplemented by a new continuous strip plant at Port Talbot on the coast as part of an integrated plant with blast furnaces and steelworks. Cold reduction plant for making tinplate will be set up in the Swansea and Llanelly districts to make two-thirds of the South Wales output, the other third to be made at Ebbw Vale. These are the proposals of the British Iron and Steel Federation. The Ebbw Vale plant is not tied up wholly with the tinplate trade. Much of its output, in fact, is designed for motor body sheets for the production of which the plant is particularly well adapted. The greater proximity of Ebbw Vale to the motor-body building industries in the Midlands and in the South of England gives it a certain advantage in these respects over the Swansea–Llanelly districts, but the freight differences on such a finished product as tinplate are not likely to be very substantial.[1]

Tin box-making has quite a different distribution. While tinplates are bound up with steel, tin boxes are bound up with consuming industries. South Wales had no more than 3 per cent of the total number employed in the industry in Great Britain in 1931, and this was even less than its proportion (3·7 per cent) of the total in all industrial employment. Tin boxes, though light, are bulky and take up so much more cubic space than the tinplate out of which they are made that the main transport problem is the disposal of the tin boxes rather than access to tinplate.[2] Tin box-making, therefore, tends to be located in areas where there are consuming industries rather than in areas where tinplate is manufactured. There is little or no loss of weight, but a great increase of bulk. It fulfils all Weber's conditions for location at the point of consumption. The industry is widely diffused; there are manufacturing units in every region of the country to supply industries requiring tin boxes and containers —tobacco, biscuits, confectionery, food-canning, paints, polishes, and petroleum products. The most important centres are Greater London, with over a third of those at work at the time of the 1931 Census, Hull (2,242), Merseyside (2,120), Nottingham (1,612), Worcester (793), Reading (505), Carlisle (443), Newcastle (412), Birmingham (337). It will be noticed at once that almost all of these are in precisely the same towns or conurbations as industries requiring tin containers. However, in the case of the larger establishments, the local market does not take up the whole of production, and tin

[1] *Second Industrial Survey of South Wales*, vol. I (1937), pp. 110–17. I am indebted to D. T. Williams for several of the points in this paragraph.

[2] There appears to be only one instance of a consuming industry owning and managing its own tinplate works, that of John Player & Sons, at Swansea. Some other consuming industries, of course, may have a large financial interest in a tinplate works.

boxes are sent farther afield within the same part of the country. Being an automatic machine industry, there is a certain degree of economy in large-scale working. But there is comparatively little long-distance transport, between northern and southern England, for example. Steel drums and kegs are made at widely scattered points, mainly (except Birmingham) at ports, for they are required by vegetable-oil crushers and mineral-oil refineries. Like tin boxes, they are made at the point of consumption.

The largest tube-making firm, Stewarts and Lloyds, has integrated plants, both at Corby in Northampton and at Bilston in the West Midlands, but others are specialist tube-makers removed from the site of steelworks. There have been shifts of some importance in the location of the industry. It initially developed out of the gun-barrel business of Wednesbury after the Napoleonic Wars, when gun barrels were less and gas and water pipes more in demand.[1] The West Midlands was thus an early centre. Cast iron and wrought iron were then the materials employed. When, as later, a demand for tubes for ship work and for export began to develop, coastal districts grew in relative importance. Such districts were the West of Scotland and South Wales (Swansea and Newport). The biggest areas were the West Midlands and the West of Scotland. In 1902 the largest firms, themselves the result of previous groupings, in these two districts amalgamated as Stewarts and Lloyds. In 1929 it took the decision to erect, and in 1932 began to build, an integrated plant at Corby in Northampton to make basic Bessemer steel, the best for welding purposes, for welded tubes. Labour has been transferred to the new plant from the older works of the company, especially from Scotland, dependent in part on imported Bessemer steel. Because of the suitability of its steel for welding, the Corby plant concentrates its attention on welded tubes. The South Wales plants, on the other hand, make chiefly weldless tubes. Both weldless and welded tubes were exported in about the same proportion, being one-third of output according to the 1935 Census of Production.[2] Producing a comparatively standardized and bulky product, tubes, like tinplate, are closely associated with steelworks, and as standardization develops, are likely to become increasingly closely associated.

Wire drawing is widely diffused. Almost every iron and steel district, except the orefield districts of the East Midlands, North Lincoln, and the North-west Coast, has some form of wire drawing or of wire working, and there are some additional areas, unconcerned with primary iron and steel production, such as Greater London. The chief districts, however, are Lancashire (Warrington and Manchester–Salford) and the West Riding, in which the industry

[1] G. C. Allen, *Industrial Development of Birmingham and the Black Country* (1929), p. 37.
[2] It had been higher for welded, though not for weldless, tubes previously.

is widely dispersed in almost every industrial town.[1] The next district in order of number employed is the West Midlands. These, it will be noticed, are all old-established metal-working districts. The wire-mills are in the same districts as the wire-rod rollers, but only infrequently on the same sites. Of the material used by the wire drawers in 1935, billets and bars constituted 0·11 and wire rods 0·39 million tons; it may be that this indicates the relative importance of the wire-rod makers and of the pure wire drawers respectively in this trade. Of seventeen firms listed by *Ryland's Directory* as wire-rod manufacturers, eight are also wire drawers; of 125 firms listed as wire drawers, eight are also wire-rod manufacturers. Many of the wire drawers are small establishments making, for example, stitching wire. Wire drawing requires a substantial floor space and is an industry of the small- or medium-sized industrial town rather than of the large metropolitan centre. The wire drawers are themselves makers of finished wire products. Of the wire-rope makers, half are in iron and steel districts (the North-east Coast, Scotland, Sheffield, and the West Midlands), and of these some, being shipbuilding districts, make ship's ropes; the other half is in textile districts which, particularly the Yorkshire towns, have cotton and hemp rope industries in addition. The fencing and barbed-wire manufacturers have a similar distribution, but the manufacturers of electric wire present different locational characteristics. Relatively few are themselves wire drawers and they are widely dispersed; in small rural towns having the space needed, as well as in large industrial centres presenting large markets.

The manufacture of domestic hollow-ware and of hardware, of nails and screws, of needles and pins are centred chiefly in the West Midlands, and of cutlery and files chiefly in Sheffield. These are finished articles of relatively small bulk and they can be made on a sufficient scale to supply the whole country from a single centre. They have remained in traditional iron-working centres where they were rooted at a time when they were still handicraft industries.

The iron and steel industry thus presents great internal diversity in type of location: it exhibits the complete range from sites at the point of production to sites at the point of consumption, from sites dictated by raw materials to sites modelled by factors—market, labour, historical inheritance—other than those raw materials at present employed.

[1] The proportions of the total of Great Britain are approximately one-third and one-quarter respectively, according to both Census of Production and Population Census (Industry Tables) returns.

CHAPTER VIII

ENGINEERING

A TREATMENT of engineering naturally follows a treatment of iron and steel, and, indeed, it is very difficult in practice to draw a line between them. The debates on the Iron and Steel Bill demonstrated this most clearly. The Census of Production places implements and tools in the iron and steel group: the Balfour Committee on Industry and Trade preferred to consider them along with engineering. At its other boundary engineering presents similar difficulties of definition. Nevertheless, wherever its precise boundaries may be drawn, the engineering group of industries consists primarily and essentially of the making of engines and machines and of the construction of vehicles driven by engines. It is in this sense that engineering will be considered in this chapter.

I

THE DISTRIBUTION OF ENGINEERING

In its location relative to primary iron and steel manufacture, engineering displays the characteristics of a secondary industry. Engineering is tied down to materials to a very much lesser extent and is therefore free to be practised elsewhere than on the site of blast furnaces and steelworks if other sites happen to be more convenient for other reasons. In fact, engineering is widely dispersed and is practised in every part of the country. The dispersion of engineering bears a much closer relationship to the dispersion of the working population than do any of the branches of iron and steel manufacture considered earlier, with the single exception of iron and steel founding. The exception helps to prove the point, for founding is itself often closely associated with engineering. Table L, calculated from the Industry Tables of the 1931 Census and from the Ministry of Labour returns for 1939 and 1950, sets out this general association of engineering with working population. There is no exact correspondence, but the association is much closer than between the iron and steel trades and working population or the textile trades and working population. Some regions, as the West Midlands, have noticeably a greater share of engineering than of working population; others, as Wales, have noticeably a lesser share. If these regional totals be broken up further it will be found that those areas which have a smaller proportion of engineering than of working population are frequently those with large rural and residential areas included within them, but the converse is not necessarily true, industrial South Wales having little engineering, and the

TABLE L

Regional Distribution of Engineering and Working Population

A

1931 Industry Tables	As percentage of male population in work	
	Engineering	All Industries
South-east	29·5	31·7
North, I and II	6·1	6·1
North, III	5·6	7·8
North, IV	15·1	13·8
Midland, I	16·8	10·1
Midland, II	4·7	5·5
East	2·8	3·9
South-west	4·0	4·5
Wales, I	1·1	3·4
Wales, II	0·3	1·4
Scotland	14·0	11·8
	100·0	100·0

B

Ministry of Labour Tables	As percentage of total insured employed males in mid-year			
	1939		1950	
	Engineering	All Industries	Engineering	All Industries
London and South-eastern	20·0	23·6	21·6	24·2
Eastern	4·4	5·3	5·2	5·4
Southern	5·8	4·7	5·4	4·7
South-western	6·2	5·4	5·4	5·3
Midland	15·1	9·9	14·8	9·6
North Midland	6·6	7·0	6·8	7·1
East and West Ridings	8·5	9·1	7·6	8·8
North-western	14·4	13·3	14·4	13·4
Northern	7·5	6·5	6·6	6·5
Scotland	10·3	10·3	10·0	10·1
Wales	1·2	4·9	2·2	4·9
	100·0	100·0	100·0	100·0

The regional division in the A and B parts of this table are not identical as Fig. 48 shows. It will be noticed that the agreement between regional distribution of engineering and of all industries is closer in 1950 than 1939, except in the Midland and Yorkshire.

correlation is not sufficiently definite to justify emphasis. If the regional distribution of engineering be compared with the regional distribution of blast furnaces and with the regional distribution of steelworks and rolling-mills, a most interesting general relationship appears. Blast furnaces are concentrated largely on the orefields: steelworks and rolling-mills are in part on the orefields and in part on the coalfields; engineering shops are in part on the coalfields and in part in areas entirely devoid of both coal and iron. Each stage overlaps the preceding, but the terminal points—smelting and engineering—are often entirely dissociated and the removal of engineering shops from blast furnaces is frequently acute not only in respect of absence of integration on the same site, but also in respect of wider regional distribution.

What are the factors responsible for this wide dispersion of engineering? It has been asserted in the preceding paragraph that engineering is less tied down to materials than is primary iron and steel manufacture. The Census of Production returns permit proof of this point. The weight of materials (including coal) per operative as returned in 1935 was 1,735 tons in blast furnaces, 155 tons in steelworks and rolling mills, and 9 tons in mechanical engineering shops.[1] Further, purchased electricity accounted for 2·7 per cent of the total cost of fuel and electricity in blast furnaces, 19·3 per cent in steelworks and rolling-mills, and 49·9 per cent in engineering shops. Such purchased electricity was drawn from the grid and not generated on the site of the works. On this evidence, engineering shops are free to be located on sites other than those permitting cheap assembly of materials and of fuel. They have thus a wide range of site open to them; they are essentially mobile with regard to both materials and power. Advantage of this mobility was taken during the late war to develop dispersion of engineering production. The loss of weight, to use Weber's test, involved in engineering production is very much less than that in blast-furnace work, and engineering is thus drawn away from raw material sites to sites in contact with consumers. Mobility with regard to materials gives a certain freedom to set up engineering shops in rural towns removed from supplies of materials but having lower wages and cost of living. This makes possible agricultural engineering in rural towns attracted in any case to such a site by reason of their association with the users of agricultural implements and machinery. But the management of other engineering trades besides agricultural engineering may find the lower wage-rates of a rural town attractive.[2] The second set of

[1] Unadjusted for size of sample and for duplication.

[2] An example was given by a witness before the Tariff Commission in the period 1904–8. A firm manufacturing wood-working machinery moved from London to Newark specifically because 'the wages in the district are the lowest in any part of the country for engineers' work' (*Report* of the Tariff Commission, vol. IV, para. 713).

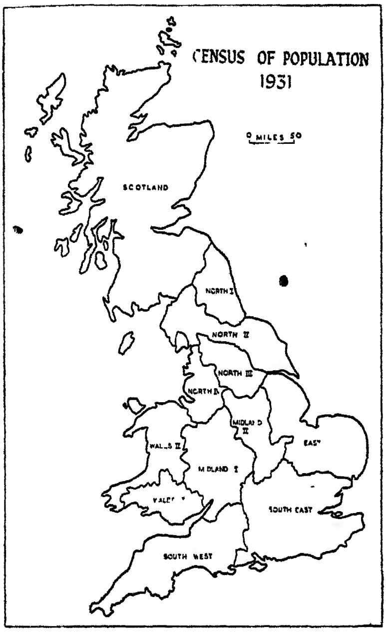

Fig. 48A

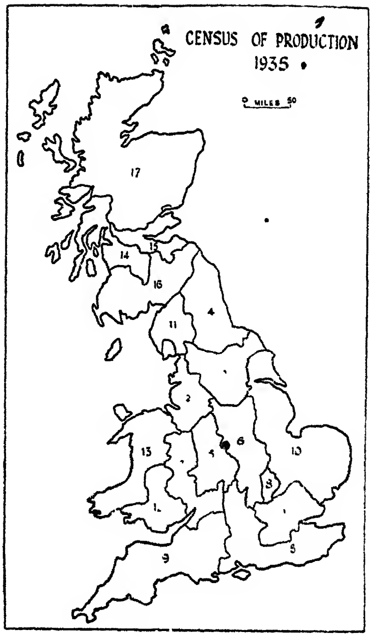

Fig. 48B

Fig. 48C

Fig. 48D

SOME REGIONAL DIVISIONS OF GREAT BRITAIN FOR STATISTICAL PURPOSES

A. Census of Population, 1931
B. Census of Production, 1935
C. Milk Marketing Scheme.
D. Ministry of Labour, 1946

factors responsible for the wide dispersion of engineering is the diversity of the market which it supplies—agricultural machinery for rural districts, textile machinery for textile manufacturing districts, and, to give another example, shipbuilding for coastal and overseas shipping services. As will appear later in this chapter, machine-making and vehicle assembly industries developed originally in close physical association with the industries which they serve. The textile engineer must needs be in close contact with the textile manufacturer if his designs are to be effective in practice; the agricultural engineer must be in close contact with the farmer so that the implement or machine can be efficiently adapted to the work it will be called on to perform. Subsequently, many British engineering industries, originally set up to supply a home market, developed an export trade of large dimensions which, supplying capital goods, grew steadily as the Industrial Revolution abroad proceeded. In some engineering trades the export came to exceed the home market, but migration to the coast did not develop on any scale, as it did in some of the finished iron and steel trades, for the machines were of great value in proportion to weight and bulk, and could therefore bear the costs of transport from factory to port. Some engineers, such as constructional engineers making bridge shapes for export, do need a coastal site, for their products are heavy and bulky in proportion to value; these, however, involve only a small segment of the large and diversified field of engineering.

The geographical distribution of engineering in its total sense is far from static. There have been profound regional changes even within the limited span of twelve years, between the Third (1924) and the Fifth (1935) Censuses of Production. Regional shifts within these twelve years had a magnitude equivalent to one-eighth of the total numbers employed. They are set out in Table LI. The areas which have declined are all coalfields; the areas which have increased are non-coalfields, with the single exception of the West Midlands. Increase in the West Midlands, however, has been largely in those parts of the region external to its coalfields. If the West Midlands be excluded, it would appear that the coalfield regions had almost half of total engineering employment in 1924, but little more than a third in 1935, and that the non-coalfield regions had little more than a third in 1924, but almost half in 1935. Though the areas are larger and more composite, the returns of the Ministry of Labour, set out in the lower part of Table LI, confirm these shifts in regional location. The unemployment returns of the Ministry of Labour, as might be expected, show that unemployment in engineering is much more severe in the declining than in the expanding districts, the percentage of insured unemployed in mid-July 1938 being, for example, 4·8 in the London Division, but 10·6 in the North-eastern

TABLE LI

Changes in Regional Distribution of Engineering Trades

A—Census of Production Returns

		As percentage of numbers employed in Great Britain			
		1924	1930	1935	1935 as percentage of 1924
1	Greater London	17·4	19·8	25·3	145
2	Lancashire-Cheshire	18·4	17·1	15·1	82
3	West Riding of Yorkshire	7·4	5·7	6·0	81
4	North-east Coast	8·0	7·4	4·6	58
5	Warwick, Worcester, Stafford	17·6	19·5	21·5	122
6	East Midlands			4·8	
7	Salop, Hereford, Gloucester			1·8	
8	South-east	16·3	17·2	5·7	107
9	South-west			1·3	
10	East			3·7	
11	Cumberland, Westmorland			0·2	
12	South Wales	1·2	0·9	0·8	67
13	Rest of Wales	0·2	0·1	0·1	50
14	West Central Scotland	10·6	9·8	7·0	66
15	East Central Scotland			1·2	
16	South Scotland	2·9	2·5	0·4	72
17	North Scotland			0·5	
		100·0	100·0	100·0	

B—Ministry of Labour Returns

As percentage of numbers of insured employed in Great Britain						
	June 1924	June 1929	June 1938		July 1939	July 1946
London	14·1	14·3	19·4	London, South-eastern	21·4	19·6
South-eastern	8·1	9·3	9·4	Eastern	4·9	5·2
South-western	6·4	7·6	8·7	Southern	4·8	5·5
Midlands	21·0	22·7	22·3	South-western	5·9	5·7
North-eastern	18·8	16·6	9·6	Midland	17·5	15·8
North-western	18·3	17·3	14·2	North Midland	7·0	7·5
Northern	—	—	5·9	E. and W. Ridings	9·1	9·0
Scotland	12·2	11·3	9·7	North-western	14·2	14·9
Wales	1·1	0·9	0·8	Northern	5·7	5·6
				Scotland	8·4	9·2
				Wales	1·1	2·0
	100·0	100·0	100·0		100·0	100·0

There have been some changes in area between 1929 and 1938 in the Ministry of Labour Divisions; the Northern Division has been constituted out of the North-eastern and North-western (the former contributing the North-east Coast and the latter Cumberland and Westmorland) and the London Division expanded at the expense of South-eastern. The year 1946 has been added for comparison: it registers the dispersal away from London and the Midlands during the late war. The percentages in this table include both males and females.

Division.[1] This change in relative regional dominance is a change within engineering in its total sense, and is a change within a highly composite group of industries. It is largely due to a relative decline in old forms of engineering, as textile engineering, and to a growth, both relative and actual, in new forms of engineering, as motor-vehicle assembly. The old forms were centred primarily on the coalfields: the new forms are largely removed from them. In a Memorandum on the Location of Industry, forming Appendix II of the *Report* of the Barlow Commission on the Distribution of the Industrial Population, Prof. J. H. Jones shows that the relative growth of industry (including engineering) in Greater London has been due to the circumstance that its industrial structure consists primarily of new industries which are expanding and scarcely at all of old industries which are contracting.

Although engineering is widely dispersed, it does not consist of small units. Table LII displays the dispersion of engineering shops into size-groups side by side with the dispersion into size-groups of iron- and steelworks and of all factories.

TABLE LII

Size of Engineering Shops

According to numbers employed in 1935

(Census of Production)

Size Group	Engineering	Iron and Steel	All Factories
Under 100	16·2	19·3	25·5
100– 499	25 2	39·7	39·1
500– 999	15·2	16·9	13·9
1,000–1,499	10·1	8·7	6·3
1,500 and over	33·3	15·4	15 2
	100·0	100·0	100·0
Average number employed per establishment	153	137	105
Average gross output per establishment	£68,000	£71,000	£58,000

It is clear that engineering shops, measured according to numbers employed, are larger than all factories, being almost half as large again per establishment. In gross output per establishment, however, the magnitude of the difference is substantially diminished and the greater average size of engineering shops than of all factories is chiefly in respect of numbers employed. This is in agreement

[1] These are not the extremes of variation, the lowest percentage being 3·8 for the South-eastern Division and the highest being 18·7 for Wales In 1946 the percentages were 1·3 in the South-eastern and 8·6 in the Northern Regions.

with the character of engineering as a secondary industry in which labour contributes largely to value of gross output.

There is one further trend in engineering that requires brief analysis, and this is the proportion of skilled, semi-skilled, and unskilled workers employed in engineering shops. Engineering labour was originally built up by craftsmen or tradesmen who served a long period of apprenticeship. The increasing use of machine tools has caused substantial changes, for semi-skilled machine-minders do not need a period of apprenticeship to be sufficiently skilled for the purpose. Yates has collected returns from the Engineering Employers' Federation to show this trend.[1] The percentage of skilled decreased steadily from 60 in 1914 to 50 in 1921 and 32 in 1933; the percentage of semi-skilled increased steadily from 20 in 1914 to 30 in 1921 and 57 in 1933, an increase which is greater than the decline of the skilled, for unskilled labour has been upgraded in addition. This has had important repercussions on trade-union organization, as Yates has shown. It has implied a growth of the general labour unions among the semi-skilled whose membership the craft unions did not at first encourage. It has implications also in respect of industrial location. Semi-skilled workers, or those who can be comparatively quickly trained to semi-skilled standards, are generally available, but skilled workers who have served long apprenticeships are necessarily more localized and tend to be focused on the older sites. The increasing dominance of the semi-skilled thus gives engineering shops greater freedom of site, and construction in the South of England, where craft unions are less well developed and apprenticed skilled workers available in relatively fewer numbers, is thus made possible.

Engineering, considered so far in its total sense, is itself very composite. It includes industries varying in their precise geographical distribution and in their precise trend of development over a series of years. It is necessary, therefore, to consider each separately. Table LIII sets out the relative size of the major groups and their trend in employment, according to the returns of the Census of Production. Mechanical engineering is the largest group, and as a group it has maintained a steady level of employment. Shipbuilding was prior to the late war a declining trade, for reasons which will be discussed later. Electrical engineering, motor and aircraft construction are growing trades, both actually and in relative share of total engineering employment. The composite character of engineering, indeed, is obvious and well known. Particular engineering shops, though they may be wholly mechanical or wholly electrical engineers, often make a wide variety of products. Some have developed this variety by their association with cognate industries, others in order to compensate for declining demand of a hitherto staple line.

[1] M. L. Yates, *Wages and Labour Conditions in British Engineering* (1937), p. 32.

TABLE LIII

Changes in Relative Importance of Groups of Engineering Trades

	1924	1930	1935	Percentage of total engineering	
				1924	1935
Mechanical Engineering:					
Actual numbers employed . .	448,202	455,473	432,811	45·5	39·2
Index numbers	100	102	97	—	—
Electrical Engineering.					
Actual numbers employed . .	150,884	191,970	247,948	15·3	22 5
Index numbers	100	127	164	—	—
Shipbuilding:					
Actual numbers employed . .	141,867	133,453	82,020	14·4	7·4
Index numbers	100	94	58	—	—
Motor and Cycle:					
Actual numbers employed . .	192,708	241,012	279,748	19·6	25·3
Index numbers	100	125	145	—	—
Aircraft:					
Actual numbers employed . .	11,735	21,322	35,032	1·1	3·2
Index numbers	100	182	299	—	—

II

AGRICULTURAL, LOCOMOTIVE AND TEXTILE ENGINEERING

Let us consider, first, particular branches of mechanical engineering. There is not space to deal with each, and only samples can be examined, but those chosen are representative samples and display the factors governing the distribution of this type of engineering shop.

Agricultural engineering is widely distributed. The Industry Tables of the 1931 Census have an entry for every county. Moreover, exactly two-thirds of the numbers at work in England and Wales were in administrative areas other than the county borough; that is, they were removed from the large towns. For all industries and services the numbers at work in the county boroughs were exactly half the total. Agricultural engineering in county boroughs, moreover, was chiefly in the smaller centres of the county town type, as Ipswich or Lincoln. Agricultural engineering, in fact, is a widely dispersed small town industry and, although this does not necessarily follow, there are many small firms as well as large. It has these characteristics partly because of its origins, the earliest agricultural engineers being local blacksmiths making implements for local use. It is still convenient for the industry to be thus in the midst of rural country and so in close contact with the users of its implements and machines. It has these characteristics also partly because weight of materials are small and cost of materials as a percentage of value of gross output small also, so that a rural town site removed

from raw materials and fuel does not restrict its development; moreover, purchased electricity drawn from the almost ubiquitous grid amounted in 1935 to over a third of total fuel and electricity costs. Wide dispersal in many centres, thus bound up with its origins and not unsuited to its present character, has been encouraged by the wide variety of design; for example, in ploughs and threshing machines, to meet the requirements of different soils and of different

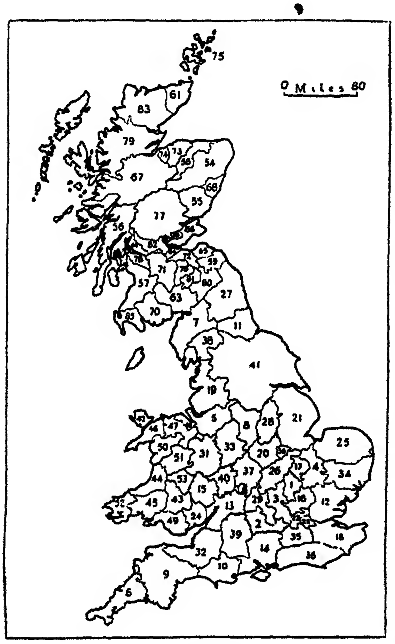

Fig. 49

MAP OF COUNTIES OF GREAT BRITAIN

1 Bedfordshire
2 Berkshire
3 Buckinghamshire
4 Cambridgeshire
5 Cheshire
6 Cornwall
7 Cumberland
8 Derbyshire
9 Devonshire
10 Dorsetshire
11 Durham
12 Essex
13 Gloucestershire
14 Hampshire
15 Herefordshire
16 Hertfordshire
17 Huntingdonshire
18 Kent
19 Lancashire
20 Leicestershire
21 Lincolnshire
22 London
23 Middlesex
24 Monmouthshire
25 Norfolk
26 Northamptonshire
27 Northumberland
28 Nottinghamshire
29 Oxfordshire
30 Rutland
31 Shropshire
32 Somersetshire
33 Staffordshire
34 Suffolk
35 Surrey
36 Sussex
37 Warwickshire
38 Westmorland
39 Wiltshire
40 Worcestershire
41 Yorkshire

42 Anglesey
43 Brecknockshire
44 Cardiganshire
45 Carmarthenshire
46 Carnarvonshire
47 Denbighshire
48 Flint
49 Glamorganshire
50 Merionethshire
51 Montgomeryshire
52 Pembrokeshire
53 Radnorshire

54 Aberdeen
55 Angus (Forfar)
56 Argyll
57 Ayr
58 Banff
59 Berwickshire
60 Bute
61 Caithness
62 Clackmannan
63 Dumfries
64 Dunbarton
65 East Lothian
66 Fife
67 Inverness
68 Kincardine
69 Kinross
70 Kircudbright
71 Lanark
72 Midlothian
73 Moray
74 Nairn
75 Orkney
76 Peebles
77 Perth
78 Renfrew
79 Ross and Cromarty
80 Roxburgh
81 Selkirk
82 Stirling
83 Sutherland
84 West Lothian
85 Wigtownshire

districts. Some of these different regional requirements are functional and fundamental, others may be stylistic. But the variety of design gives a greater fluidity and adaptability to varied conditions which large-scale mass production would not permit. The places, such as Leeds, Derby, and Birmingham, which do not fit into this description of agricultural engineering as a small town industry, are, at any rate in part, concerned with making lawn-mowers whose chief market is not rural but suburban. Of twenty-three firms listed as making lawn-mowers, twelve are in towns like Leeds and Birmingham, and many of the rest are in places of the *genre* of Matlock or

Maidenhead. Makers of farm implements proper, such as cultivators or corn drills, are almost without exception in county towns like Ipswich or in rural towns like Stamford or Evesham. Farm tractors, though employed wholly on agricultural work, are made rather more (in so far as number of firms is a guide) in centres like Coventry and Greater London than in towns with rural associations; tractor-making is a new industry often in the hands of automobile engineers.[1]

In consequence of this variety of design to meet local requirements, the British industry almost monopolizes the British market. The 1935 Census of Production placed the percentage of the British market supplied by British industry at 88. The chief import before the war was of reapers and binders, in which American large-scale production has specialized, and in this class of machine imports had a greater share than home production of the British market. The home market, however, is inadequate to maintain the scale of production developed by British agricultural engineering shops. The Report on the Census of Production for 1907 estimated that three-quarters of the tonnage output was exported, that for 1924 placed the percentage of export at 41, for 1930 at 45, and for 1935 at 25 by value. In order to maintain their level of employment, agricultural engineering shops have been compelled to develop other forms of engineering. Ipswich, for example, had fewer agricultural engineers in 1931 than engineers of other descriptions; it had had more agricultural engineers in 1921. Output increased strikingly, however, during the late war and in 1946–7.

Locomotive engineering is an old-established British industry, Britain being the home of the locomotive railway and the point from which it was diffused over the world. Locomotive engineering in Britain, however, has developed in two separate compartments—locomotive building and repairing by the railway companies and locomotive building by private companies independent of the railways. This distinction affects the location of locomotive shops, and it must accordingly be considered at the outset. The railway companies have supplied the greater part of home requirements, but they have built only for their own individual use and not for sale to other railway companies.[2] This left the market of the smaller railways, whose scale of operation was insufficient to maintain a locomotive works, open to the private companies, and it was expected, though these expectations were not immediately realized, that this market would disappear after the absorption of the smaller companies by the larger, consequential on the Railway Act of 1921. The private companies, therefore, had come to rely primarily on export markets.

[1] The Census of Production does not class farm tractors with agricultural machinery. Although farm tractors are designed for agricultural use, the *Report* on the Census recognizes that their manufacture has quite other affiliations.

[2] Balfour Committee on Industry and Trade, *Minutes of Evidence*, vol. II, p. 928, Q. 14652–3.

In 1889 the private companies had sold 51 per cent of their output to home railways; in 1913 or thereabouts the percentage had fallen to 8.[1] The numbers employed by the two branches of the trade in Great Britain in 1931 were 47,355 by the railway companies and 17,484 by the private companies. This does not give, however, an accurate index of the relative scale of locomotive building, for the greater part of those employed by the railway companies are on repair work.[2] In 1907 the railway companies built 32,415 tons of new locomotives and the private companies 86,000 tons;[3] in 1924 the numbers of new main-line[4] (standard gauge) locomotives built were 223 and 401 respectively, and in 1930, 324 and 608 respectively. In 1935 the private companies built 363 main-line locomotives with a total tonnage of 29,998, while the railway companies constructed 375 with a tonnage of 26,270. It would thus appear that the scale of output has fallen,[5] but it is by no means certain that this is due to a deterioration in the relative competitive position of British locomotive-makers *vis-à-vis* other exporting countries. The Balfour Committee, after admitting imperfection of statistics, declared in 1928 that 'it would appear that the United Kingdom is more than maintaining its pre-war share of the aggregate of the exports of the first three exporting countries'; that is, of the aggregate exports of the United Kingdom, the United States, and Germany.[6] The volume of export had fallen by reason of the greater diffusion of locomotive building throughout the world for home use rather than by reason of any deterioration of competitive position on the part of Britain relative to other exporters.[7]

Within Britain locomotive building and repairing by the railway companies is widely scattered in centres such as Crewe, Swindon, Derby, Doncaster, Darlington, and the like. Some of these towns are

[1] Balfour Committee, *Minutes of Evidence*, vol. II, p. 931, Q. 14696–9.

[2] In 1924, of the value of gross output in railway locomotive shops owned by the railway companies 66·6 per cent was repair work. In 1930 the percentage was 63·5. Moreover, the 1931 Census classification includes, with locomotive railway engine-makers and repairers, those employed in making railway plant, such as signals, turn-tables, and wagon axle boxes, and also steam-driven road vehicles. The returns of numbers at work quoted in the text, therefore, do not refer wholly to railway locomotive work.

[3] The 1907 returns include contractors' and light locomotives as well as main-line rail locomotives.

[4] The locomotives built other than main line are contractors' and light locomotives. While the main-line locomotives in 1935 had an average weight of 83 tons, the rest had an average weight of little more than 7 tons.

[5] In 1943–6 average annual output was identical with that of 1935

[6] Balfour Committee, *Survey of Metal Industries* (1928), p 176.

[7] The course of export of locomotives during the inter-war period has displayed fluctuations of violent amplitude as between boom and depression, export in 1932 being only 9 per cent by value of export in 1930. Recovery after the depression had attained only half the 1929–30 level by 1939. Locomotives are capital goods of great value, and the trade in them necessarily fluctuates violently unless orders are consciously spread over a series of years. In 1946 the numbers exported were almost exactly half of the number built.

primarily railway creations and would not exist as urban centres apart from their railway shops; others are more general engineering centres with locomotives as only one of their specialisms. Some of the smaller centres lost much of their locomotive work on railway amalgamation. But, while the building of new locomotives may be focused on a single plant within the railway company's system, repairing equipment must be available at many scattered points. The Census returns show that locomotive engineers, in fact, are widely dispersed in fairly small groups as well as concentrated into large groups, as at Crewe or Swindon. It is not clear why the railway companies so frequently established their locomotive works at a new centre in the midst of rural country, unless it was to draw upon a rural reservoir of labour at a time when labour in the towns was becoming scarce owing to rapid industrial expansion, for existing towns were then small and had comparatively little population. The origins of the distribution of railway locomotive shops lie far back in the early decades of railway development and the rationale of their location must be sought in the conditions at that time. The private companies building locomotives have a more circumscribed distribution. They are relatively few in number and they have come to depend primarily, it will be recalled, on export markets. Though valuable, finished locomotives are bulky and, if delivery is to be made by road as is sometimes the case,[1] the locomotive shop must not be too far distant from the export port, and, moreover, the port of export must be such that it can offer liner services to a wide variety of destinations. In 1938 85 per cent of exports were from the three ports of Liverpool, Glasgow, and Manchester, 58 per cent being from Liverpool alone and 25 per cent from Glasgow. The most important regions have thus come to be South-east Lancashire, the West of Scotland, and, with a lesser bulk of production, the North-east Coast and the West Riding of Yorkshire. These are also general engineering centres, unlike some of the railway locomotive towns, and most of these centres have built locomotives from the beginning of the railway era. Some of the locomotive builders make their own parts, such as locomotive boilers, but these are also often bought in from other engineering shops usually, though not invariably, in the same districts. Locomotive boilers are made by non-locomotive builders, such as Vickers-Armstrong or Ruston and Hornsby, as well as by the locomotive building firms themselves.

Textile engineering is a traditional specialism of Britain, the home of textile manufacture as of the locomotive railway, and it has provided not only British mills with their machinery, but also mills abroad. It is a mobile industry in the sense that weight of materials used and cost of materials as a percentage of the value of gross output

[1] Such locomotives destined to be exported from Liverpool may be encountered on the East Lancashire Road.

are both small, and it thus tends to be located at its market,.the textile manufacturing districts. It happens that these are coalfield sites, and that textile machinery-makers use substantial quantities of coal and coke, but it is the market rather than the coalfield that draws the industry. Of those at work in textile machine-making, according to the 1931 Industry Tables,[1] 99 per cent were in the four

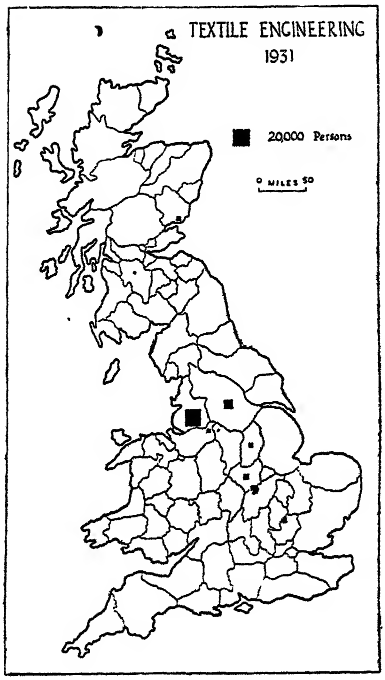

Fig. 50

PERSONS AT WORK IN TEXTILE ENGINEERING IN GREAT BRITAIN BY COUNTIES, 1931

Census districts of North IV (Lancashire–Cheshire) with 67 per cent, North III (West Riding) with 19 per cent, Midland II (East Midlands) with 8 per cent, and Scotland with 5 per cent. It is as necessary that textile machine-making should be in the textile manufacturing districts as that agricultural engineering should be in farming districts in order to be in close working contact with the consumer.

[1] The precise percentage importance of each of the four major districts differs as between the returns of the 1931 Industry Tables and the returns of the 1935 Census of Production The 1931 returns give a higher percentage than the 1935 returns to Lancashire-Cheshire and a lower percentage to the others. It is conceivable that, despite the differing source of these two returns, these differences in this case represent changes in time as between 1931 and 1935.

The location of textile engineering is even further specialized, for, within Lancashire, for example, the makers of spinning machinery are chiefly in the spinning district and the makers of weaving machinery within the weaving district. Within the textile manufacturing districts textile machinery-makers are fairly generally dispersed. Nearly every Lancashire and West Yorkshire textile town has one or more firms, but the largest single centres are Oldham, Bolton, Rochdale, Accrington, Blackburn, Greater Manchester, Leeds, and Keighley. Within the East Midlands the chief centres are Nottingham and Leicester and within Scotland, Dundee. Though mainly within the same regional areas of the country, the manufacturers of textile machinery accessories are not always located in precisely the same places. The bobbin-makers are placed not in primarily textile towns, but frequently at points with access to supplies of timber. Bobbin-makers were formerly dispersed in the woods and a number of such bobbin-mills still remain in the Lake District, for example. The largest bobbin-mill, however, is now at Garston, on the Mersey estuary; it began in a Pennine valley and migrated in order to be closer to its materials, imported from overseas, and to its markets, which include textile districts abroad. Textile machine-making has developed a bulk of output which the home market is insufficient to absorb. Textile machinery has a fairly substantial life and, although renewal is advised after approximately thirty years of use, it may be employed much longer than this. In times of depression, as in the Lancashire cotton industry during the inter-war period, machines are kept in use long after the point of their maximum efficiency. Thus, 95 per cent of the output of spinning and weaving machinery was exported in 1924 and 67 per cent in 1935; in 1930[1] export exceeded output. Export of other forms of textile machinery and of accessories represents a much smaller proportion of output. For the whole group exports were 58·5 per cent of output in 1924 and 56·1 per cent in 1935. There has been an actual increase on the basis of value in both output and export of hosiery and knitting machines.[2] These differential changes probably resulted in decreased employment in Lancashire–Cheshire and increased employment in the East Midlands. The actual volume of exports declined substantially during the inter-war period, from 178,000 tons in 1913 to 127,000 tons in 1929 and 79,000 tons in 1937.[3] Thus both home and export demands have fallen and many textile machine-makers, like many agricultural engineers, have reduced the

[1] Export would be partly of machines actually made in 1929 and largely of orders placed in 1929 at a period of trade boom.

[2] As percentages of the 1924 level output and export in 1935 were 75 and 53 per cent respectively for spinning machinery, 47 and 26 per cent for weaving machinery, 85 and 84 per cent for bleaching, dyeing, and finishing machinery, 123 and 278 per cent for hosiery and knitting machines.

[3] It was 83,000 tons in 1947.

level of their employment and, wherever possible, have developed other forms of machinery production.

Constructional engineering is widespread and has a diffusion throughout Britain not dissimilar to that displayed by engineering in its total sense. Some regions, for example, the North-east Coast, South Wales, and the West of Scotland, have a greater percentage

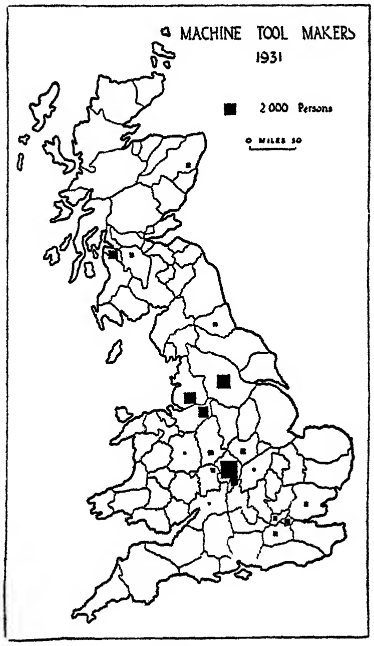

Fig. 51

PERSONS AT WORK IN MACHINE TOOL MAKING IN GREAT BRITAIN BY COUNTIES, 1931

of constructional engineering than of total engineering;[1] others, for example, the east and the south-east, have a lesser share of constructional engineering. It appears probable that the numbers employed in constructional engineering comprise not only those working, for example, in bridge and girder work, but also those erecting the bridges when they are employed by the constructional engineering firm and not by building contractors. The reasons for this wide dispersion are not difficult to discover. Constructional engineering material is bulky[2] and has frequently to be made up

[1] There was a large increase in the numbers employed in the South-west and North-west regions of the Ministry of Labour in 1946.

[2] While the weight of metal per person employed was 5·5 tons in 1935 for mechanical engineering generally, it was 23·0 tons for constructional engineering.

into finished shapes and sections near to the point of erection. Work for steel-framed buildings is usually contracted for within that particular part of the country. The bulkiest product, however, is not the raw material, but the finished product, and it is the bulkiness of the finished product that is responsible for wide dispersion near to market. This is pronounced in respect of bridge-building material for export. It is frequently made and broken up into sections for transport overseas at coastal or sub-coastal plants where facilities for loading direct into liners' holds exist.

III

SHIPS, MOTOR VEHICLES AND AIRCRAFT

The samples of mechanical engineering production just considered employ primarily metal as their fundamental raw material, and the engineering shops fashion the metal into the form required by the consumer. That does not mean, as we have seen, that they are located necessarily at the sources of metal supplies, indeed, the reverse is now commonly the case, whatever it was in the early nineteenth century. We turn now to a number of vehicle-building industries—shipbuilding, motor-vehicle building, airframe assembly—which display somewhat different characteristics. They frequently buy their metal in a form completely fashioned and they use many other materials as well as metals. It is the vehicle rather than the engine contained in it that is the primary product. They may be carried on simply as assembly industries, putting together parts prefabricated elsewhere. This is, of course, not always the case, and many vehicle assembly shops manufacture their materials, or some of their materials, as well as assemble them; but the fact that it is possible for them to be merely assembly shops is significant. Of these vehicle-building industries, shipbuilding displays the assembly characteristics in their least and airframe assembly in their most accentuated form. Although it is not possible to prove the point owing to the small sample of materials for which weights are available, shipbuilding is, in fact, less mobile than engineering in its total sense. It must be located, of course, on the coast or on a river or canal (see Fig. 52). Its location in the past has also been closely related to materials, for these are of great bulk. In the days of wooden vessels shipbuilding was focused on estuaries whose rivers passed through woods where oak could still be felled; the Thames, whose right bank tributaries led from the Weald, was the pre-eminent example. There was shipbuilding also at ports where timber from Scandinavia or from North America was imported and some British shipbuilding yards lost business to North American yards with timber available close at hand in so much greater quantities. The Mersey had shipbuilding yards of this type, and import of

planks and spars from North America was one of the major imports of the Port of Liverpool during the eighteenth century. With the construction of iron ships the Thames shipyards were one by one closed, and many Mersey yards were closed also, though there was an additional factor on the Mersey in that the sites of the yards were required for dock construction as the dock system expanded. Although they

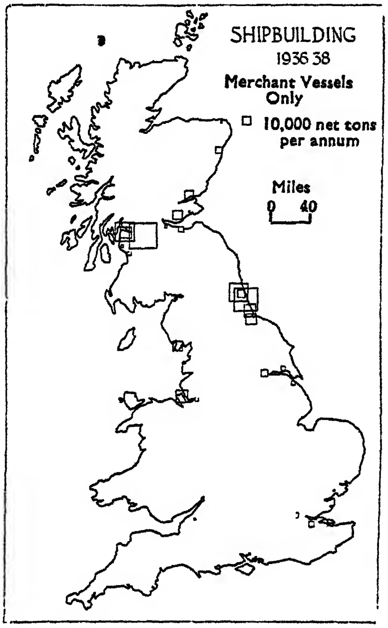

Fig. 52

SHIPBUILDING IN GREAT BRITAIN BY PORTS, 1936–8

Average annual tonnage launched at each port for the years 1936–8 of merchant vessels only. Map drawn from tables in *Annual Statement of Navigation and Shipping*. Overlapping squares unavoidable.

had their roots in the days before the iron ship, the yards on the Clyde and on the North-east Coast gradually grew to supersede the older centres. Their prime advantage was, and still is, the presence in close proximity to the yards of heavy iron (and later steel) industries with their plates, girders, beams, and joists. It is the expense of moving these heavy materials that helps to fix shipbuilding yards in those heavy iron and steel districts which are coastal in location. But there is also an additional factor in the form of the space required by the yards. In large ports space is monopolized by docks and quays and there is little to spare for shipbuilding yards unless, as happens on the Clyde, a long, deep-water estuary is available.

London is now a very minor shipbuilding centre with only 1·4 per cent of the merchant tonnage launched in ports of Great Britain during the five years 1934–8; the port of Liverpool (including Birkenhead), although more important as a shipbuilding centre, had only 5·9 per cent of the tonnage launched during the same period. The two ports together had 27·6 per cent of the tonnage of entrances of vessels with cargo and in ballast, but only 7·3 per cent of the tonnage of vessels launched. The relative importance of the several stretches of the coast of Great Britain is set out in Table LIV. The North-east Coast and the West of Scotland were responsible for 89 per cent of the total tonnage launched in 1914 and for 76 per cent in 1934–8. On the North-east Coast the yards are on Tyneside, at Sunderland and on Teesside, in that order of importance. In the West of Scotland they are chiefly on the Clyde, at Glasgow, Port Glasgow, and Greenock, in that order. The other districts are quite secondary in relation to these. The East Scottish shipbuilders are in Dundee, Burntisland, Leith, and Aberdeen. The East England yards are at London, Hull, and the East Anglian coast, but these make only small vessels, averaging under 100 tons, as compared with vessels of 2,000 tons and over which are constructed in the two major districts. The most important centres in North-west England are Barrow-in-Furness and Birkenhead. In order to link up these shipbuilding returns with other shipbuilding and repairing statistics which will be considered shortly, it is essential to point out that they refer only to building, taking no account whatever of repairing, and that they exclude warships whether built for the Admiralty or for foreign governments. The Census of Production material, which includes repairing with building and does not distinguish between warships and merchant ships built in private yards, is set out in Table LIV. It is at once clear that shipbuilding and ship-repairing combined are more widely dispersed than shipbuilding alone. While the two main shipbuilding districts, the North-east Coast and the West of Scotland, had 76·1 per cent of total tonnage launched in 1934–8, they had only 39·3 per cent of numbers employed in shipbuilding and repairing in private yards in 1935. Conversely, while the port of Liverpool had 5·9 per cent of the tonnage launched in 1934-8, it had 11·1 per cent of the numbers of insured employed in shipbuilding and repairing in all yards. Ship-repairing yards are located at general ports as well as in shipbuilding districts. Ship-repairing, moreover, is as widely dispersed as the tonnage of shipping entering and clearing in the course of trade, the port of Liverpool having 12·0 per cent of the tonnage entering with cargo and in ballast in 1938. Ship-repairing facilities, like locomotive-repairing facilities, must be widely dispersed. Shipbuilding and repairing have not only different distributions, but also different amplitudes of variation. As ships are a form of capital investment, shipbuilding

TABLE LIV

Distribution of Shipbuilding in Great Britain

(excluding war vessels)

	As percentage of total tonnage launched			1938 as percentage of 1914	1935 as percentage of 1924
	1914	1922–6	1934–8		
North-east Coast . . .	56·1	42·3	33·7	38	23
West coast of Scotland . .	32·9	40·5	42·4	92	31
East coast of Scotland . .	2·5	4·5	6·8	170	62
East coast of England* .	5·4	4·6	5·2	30	85
North-west England .	2·4	6·3	10·9	233	87
Other coasts . . .	0·7	1·8	1·0	—	38
Great Britain . .	100·0	100·0	100·0	64	33

Calculated from the *Annual Statement of Navigation and Shipping*.
* That is, excluding the North-east Coast.

Distribution of Shipbuilding and Repairing in Great Britain

Census of Production Percentage of numbers employed				Ministry of Labour Percentage of insured males in employment			
	1924	1930	1935		1939	1945	1950
North-east Coast	26·2	27·2	27·5	Northern . .	21·8	21·2	21·9
West of Scotland	25·4	23·9	21·8	Scotland . .	26·6	26·1	25·4
Rest of Scotland .	5·1	4·4	4·2	North-western	14·6	16·2	15·1
Lancashire–Cheshire .	10·7	12·8	16·2	London and South-eastern	8·9	8·5	10·0
Greater London	9·7	6·8	8·9	Southern . .	13·7	11·3	10·6
Rest of England	13·2	13·9	18·8	South-western .	7·0	6·2	7·5
Wales . .	4·4	3·6	2·6	Rest of England .	5·0	6·6	6·0
Northern Ireland	5·3	7·4		Wales . .	2·4	3·9	3·5
Total U.K. .	100·0	100·0	100·0	Total G.B. .	100·0	100·0	100·0

The Census of Production returns refer to private yards alone and the Ministry of Labour returns to those in the insurance scheme which excluded those 'in an established capacity in the permanent service of the Crown' in 1939 and 1945, but not in 1950.

varies widely between boom and depression. Ship-repairing has a smaller amplitude of variation for ships require repair in depression as in boom, though the tendency is to delay all but the most urgent repairs until more prosperous times. Moreover, in times of depression there are fewer ships on the high seas. On Merseyside, where repairing is more important than building, the percentage of the total of

insured employed of Great Britain is greater in times of depression than in times of boom;[1] in shipbuilding districts there is the reverse variation. The North-east Coast and Scotland have thus a greater amplitude of variation than districts which concern themselves with repairing rather than with building.[2]

It will be observed from Table LIV that there have been changes in the relative importance of shipbuilding in the two main districts, the North-east Coast and the West of Scotland. The West of Scotland during the inter-war years had increased its percentage share of the total output. On the other hand, the North-east Coast had declined both actually and relatively.[3] Prof. Hallsworth explained the difference on the grounds that the North-east Coast has had a lesser experience of building giant liners than has the West of Scotland.[4] Tramps and tankers constitute the main, though by no means the only, classes of merchant shipping built on the North-east Coast. Within the North-east Coast region, Teesside has declined more than Tyneside or Sunderland.[5] Some of the secondary shipbuilding districts had increased their output actually and relatively. This greater diffusion is an example of a greater diffusion of engineering in its total sense, but in shipbuilding it has been encouraged by the establishment of a uniform delivered price for plates and sections whatever the origin of the material. This clearly implies that the advantages of the West of Scotland and of the North-east Coast in proximity to plate-mills were becoming less and less substantial. Some minor shipbuilding ports had rather lower wage-rates, which may have given them some cost advantages, but this was most conspicuously true of Aberdeen, which had a balancing disadvantage in the form of high cost conditions in respect of steel, for outlying ports such as Aberdeen did not receive the advantages of the uniform delivered price.[6] Wages of shipwrights on the North-east Coast and in the West of Scotland appear to have been identical for new work,

[1] W. Smith, *The Distribution of Population and Location of Industry on Merseyside* (1942), pp. 62–3 and Fig. 10

[2] 1924 had an output comparable in magnitude to that of 1929, a year of boom, and the year 1935 had an output which was only beginning to recover from the Great Depression. Thus, while tonnage launched in 1935 was 33 per cent of tonnage launched in 1924, numbers employed in shipbuilding and repairing in 1935 were 58 per cent of numbers in 1924.

[3] The North-east had a much larger share of shipbuilding than the Clyde in 1914, and still had a larger share in 1929, but it recovered from the Great Depression much more slowly. In the summer of 1939 trade papers reported that, while the Clyde yards were busy, the North-east Coast badly needed more orders.

[4] H. M. Hallsworth, 'The Shipbuilding Industry', in *Britain in Recovery*, ed. by J. H. Jones (1938), p. 346. He had discussed the difference earlier at great length, but without arriving at any conclusions as to cause in the *Industrial Survey of the North-east Coast Area* (1932).

[5] Teesside had more old-fashioned yards and, as these were controlled by private companies, they had not the same financial resources for re-equipment.

[6] *Abstract of Labour Statistics* (1937) gave the wages of shipwrights for new work at 62*s.* per week for Middlesbrough, Newcastle, Glasgow, Belfast, Southampton, and Hull, but 61*s.* for Dundee and 60*s.* for Aberdeen.

and were only slightly lower in the West of Scotland for repair work.[1] These changes in relative position as between one district and another were in progress before yards were closed by the activities of National Shipbuilders' Security Ltd. Although there is no clear evidence to this effect, it is by no means impossible that some differences in relative output capacity as between port and port did develop as a result of these closures.[2] It is thus evident, whatever the causes may be, that the precise relative geographical distribution of shipbuilding is far from static.

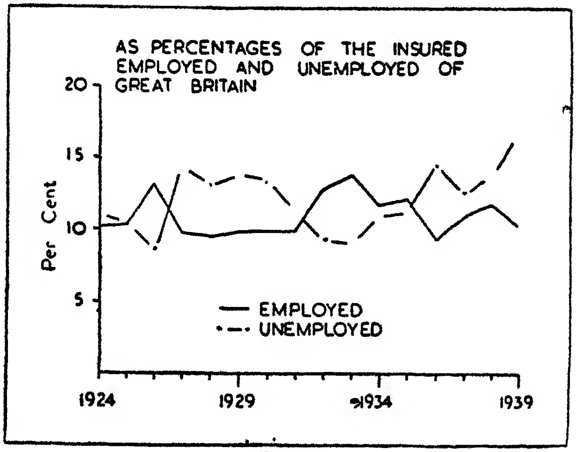

Fig. 53

ANNUAL VARIATION IN NUMBERS OF PERSONS IN SHIPBUILDING AND SHIP-REPAIRING ON MERSEYSIDE, 1924–39

Number of persons on Merseyside expressed as percentages of the insured employed and insured unemployed of Great Britain. Broken line is of insured unemployed, unbroken line of insured employed.

The bulk of the shipbuilding output of Great Britain had declined during the inter-war period. According to the returns of Lloyd's *Annual Summary* it was 1·93 million gross tons in 1913, 1·52 million gross tons in 1929 and 0.92 million gross tons in 1937, 1929 and 1937 both being trade-cycle crests and thus comparable with 1913. This declining output represented a declining share of the world total from approximately 60 per cent prior to the 1914–18 war to 55 per cent in 1929 and 34 per cent in 1937.[3] World shipbuilding at trade-cycle crests had been comparable in magnitude. Britain was the first to develop the building of iron ships on a large scale, as it had been the

[1] *Abstract of Labour Statistics* (1937). Rates on repair jobs were 65*s*. weekly for the North-east Coast and 64*s*. 3*d*. for the West of Scotland.

[2] H. M. Hallsworth, in *An Industrial Survey of the North-east Coast Area* (1932), pp. 264–7.

[3] It is approximately 40 per cent at the time of writing.

first to develop locomotive and textile engineering, but, with the greater diffusion of these industries throughout the world as the Industrial Revolution abroad has proceeded, Britain's percentage share has necessarily declined. The actual, apart from the relative, decline of shipbuilding in Britain was a response to restrictions in both home and export markets. The lesser requirement of British

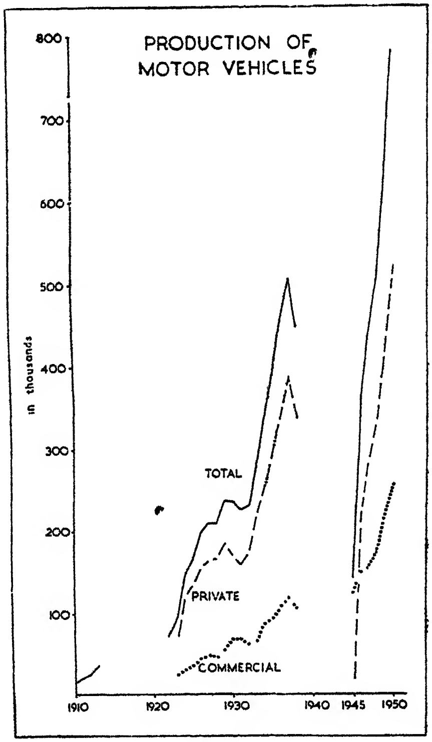

Fig. 54

PRODUCTION OF MOTOR VEHICLES IN GREAT BRITAIN, 1910–50

The diagram distinguishes commercial, private and total motor vehicles. The interruptions in the continuity of the curves are due to the two wars. Drawn from tables in the *Motor Industry of Great Britain* (1939) and in the *Monthly Digest of Statistics.*

ships by foreign shipping companies had been due to competition by shipbuilders abroad, some of whom were supported by State bounties in one form or another. The demand of British ship-owners had been restricted equally with that of foreign ship-owners. Decline in activity implied a redundancy of shipbuilding capacity which, from the shipbuilders' point of view, it was desirable to reduce, for it increased his fixed charges and thereby increased his costs. A reserve of shipbuilding capacity, however, is necessary in times of peace on

account of the large amplitude of fluctuation of activity in ship-building yards, being high in boom but very low in depression. A reserve is doubly necessary if there is risk of war, in order to replace war losses which are severe. National Shipbuilders' Security Ltd. was constituted in 1930 to deal with the redundancy problem in Britain. By the end of 1934 berths with an annual building capacity

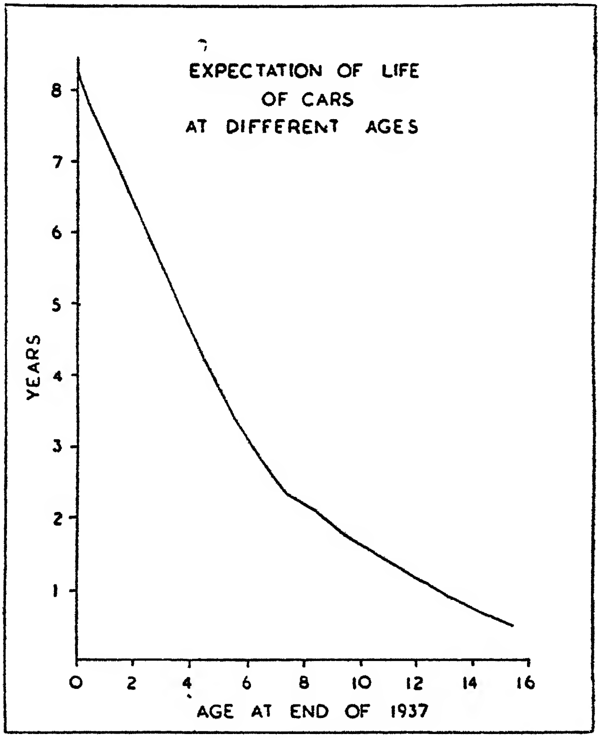

Fig. 55

EXPECTATION OF LIFE IN 1937 OF CARS AT DIFFERENT AGES

This actuarial diagram applies only to the market and replacement conditions of the 'thirties. Drawn from the table in the *Motor Industry of Great Britain* (1939)

of one million tons had been dismantled, but there was little further dismantling after that date.[1] The maintenance of a reserve of ship-building labour presents a much more difficult problem than the

[1] H. M. Hallsworth, in *Britain in Recovery*, p. 353. During the late war twenty-three yards had been reopened by the autumn of 1942. For the problems involved in merchant shipbuilding and repairing during the war, see the *Seventeenth Report* of the Select Committee on National Expenditure (session 1941–2). The number of ships built has increased and vessels completed June 1946–June 1947, totalled 0·94 million gross tons, identical with 1937. In 1949 tonnage completed was 1·35 and in 1950 1·39 million tons (*The Economist*, vol. CLX (1951), p. 221).

maintenance of a reserve of shipbuilding capacity, for labour cannot be kept idle and yet retain its skill. The problem of redundancy, though inherent in the nature of shipbuilding, is at the time of writing still in abeyance and the ship-yards remain active.

Let us turn now to motor-vehicle construction, an engineering industry which presents many contrasts to shipbuilding. It is a new and growing industry, it is organized on standardized production principles, and it displays very considerable mobility in location. A discussion of its characteristics and of its growth will facilitate examination later of its regional distribution. Its growth has been rapid. The *production* of private cars and commercial vehicles up to 1946 is set out in Fig. 54. In 1913 there were *in use* 106,000 private cars, in 1929 998,000, and in 1938 1,984,000, and the increase showed no signs of falling away in 1938, the last complete year prior to the late war. Increase in number of goods vehicles had been equally steady, but of more modest dimensions, at the annual rate of 21,000 vehicles licensed at August 31, as compared with the 101,000 annual rate for private cars.[1] The mere maintenance of these numbers, however, requires an active manufacturing industry for the normal life of a motor vehicle is short and renewal frequent. The average life of a private car made in Britain, was before the war, under eight years,[2] and of an American car less than this. The maintenance of two million private cars would ordinarily involve an annual output of approximately 250,000 new cars. There is, in addition, to be provided for an annual net export (1924–37) of 33,000 finished private cars. The production of motor vehicles. is thus an industry of large dimensions. With reconversion of the industry to peace-time production, the output of motor vehicles rose rapidly during 1946 to attain a monthly level by the end of the year almost equal to that of 1935 in private cars and two-thirds as much again as that of 1935 in commercial vehicles.[3] This level was maintained during the months of peak output in 1947.

This rapid growth has been made possible by large-scale standardized and flow production methods[4] which have cheapened the

[1] Motor-cycles increased up to a maximum in 1929, but they then fell away by one-quarter in the Great Depression and did not subsequently recover their 1929 level. Motor hackneys have been very steady in numbers from 1923 onwards, they increased slightly to a maximum in 1930, but declined afterwards; within this class there has been an actual decline of those seating eight persons and under, that is, taxicabs, and an increase in those seating larger numbers, that is, omnibuses and motor-coaches.

[2] The Statistical Department of the Society of Motor Manufacturers and Traders has worked out the life-history of motor-cars from sample investigations in Middlesex, Norfolk, and Lancashire. The standardized death rate per 1,000 cars as calculated by the Statistical Department of this Society is set out in Fig. 55. This has been constructed from Table LVIII in *The Motor Industry of Great Britain* (1939). The private cars at present on the roads have a considerably higher average age.

[3] *Monthly Digest of Statistics*, no. 25 (1948).

[4] In the discussion on a paper by F. G. Woollard in 1924, Sir H. Austin stated

cost of production and have thereby brought car ownership within the capacity of lower income levels. The first cars, like the first machines in the early phases of the Industrial Revolution a century previous, were the work of individual craftsmen, but they were expensive, were often mechanically imperfect, and were difficult to repair quickly, as spare parts were not available. Large-scale production of motor vehicles at low prices had to await, first, the provision of machine tools so that each part could be made exactly alike and so that spares could be accumulated, and had to await, second, the adoption of flow methods of assembly. The price index for new private cars decreased from 100 in 1924 to 50 in 1935,[1] a result which was due partly to the cheapening of production methods and partly to the advent of the low horse-power car.[2] The first to adopt the flow method of assembly in Great Britain was the Ford plant, whose methods of production had been developed in the United States, but it was adopted for engines in the Morris works at Coventry by 1924,[3] and it is now general among the makers of the lower-priced cars. The flow method of assembly has made possible the employment of semi-skilled workers, which in turn has facilitated a much more rapid expansion of the industry than if skilled craftsmen had to be trained in large numbers. Skilled craftsmen are required to set up the machine tools, but they form only a minority of the total personnel.[4] Flow methods have also encouraged development in districts where engineering craftsmen were relatively few in number, that is, in the English Plain, a factor in location which will be discussed further shortly. The advantages to be gained from a completely balanced system of flow production have made many motor-car works into assembly plants pure and simple, where components prefabricated elsewhere are assembled into place. The prefabrication may be done by the same firm, Morris

that 'in the United States they have found that line assembly of a car giving an output of approximately 200 cars per day, will produce practically all the big economies that are possible' (*Proc. Institution Automobile Engineers*, vol. XIX (1924), pp. 453–4). Of course, such an establishment would not turn out 200 cars daily for each of the 365 days in the year owing to interruptions due to holidays, to low rates of production in the slack season in late summer, and to change of jigs consequential on the introduction of new models.

[1] *The Motor Industry of Great Britain* (1939), p. 47.

[2] Of the cars in use in 1927, 6·9 per cent were of 8 h.p., 5·8 per cent of 10 h.p., and 25·9 per cent of 12 h.p.; in 1938, 27·8 per cent were of 8 h.p., 23·2 per cent of 10 h.p., and 14·4 per cent of 12 h.p. According to the returns of the *Monthly Digest of Statistics* the proportion of the low h.p. cars to the total in 1946 was higher still. Some changes are likely, however, in the future.

[3] F. G. Woollard, 'Some Notes on British Methods of Continuous Production', *Proc. Institution Automobile Engineers*, vol. XIX, pp. 419–74. The Proceedings of the Institution of Automobile Engineers about this date are full of papers and discussions on more economical production. There were great changes in cost of production and in volume of output henceforward.

[4] It was placed at 7 per cent in 1927 (H. Kerr Thomas, 'The Effect of the Automobile Industry on the Midlands', *Proc. Institution Mechanical Engineers* (1927), p. 630).

engines made at Coventry being assembled into finished cars at Oxford, or by other firms, for the number of components is so large and their nature so varied that they could not all be made entirely by a single firm.[1] It is customary, for example, for electrical apparatus to be made by entirely different specialist firms, such as Messrs. Lucas, and for instruments to be made similarly, by Messrs. Smith. The only firm that smelts its own pig iron is the Ford plant at Dagenham, and this is based on its American experience.[2] Not many have their own foundries or do their own stampings.[3] It would appear that under British conditions, where the medium-sized rather than the gigantic firm is the rule, many components must of necessity be drawn in from outside. Integration with iron and steel is not to be expected.[4]

Historically, motor-car manufacture developed out of cycle manufacture, which had come to be focused in Coventry. The West Midlands had for long specialized in metal products of small dimensions, and the cycle trade, requiring such components, developed in the West Midlands area. Other engineering districts—Lancashire, the West Riding, the North-east Coast, and the West of Scotland—had concentrated their attention on products of larger dimensions. Coventry, rather than any other West Midlands centre, developed cycle manufacture partly because of the availability of suitable labour owing to the decline of watch-making and of the availability of premises in the form of disused silk-mills. These factors favouring Coventry were no doubt temporary, but they coincided in time with the development of cycle manufacture. A further factor favouring the West Midlands rather than the engineering districts of the North of England and of Scotland, topographically more accidented, was the smoother landscape of the West Midlands and of the English Plain. To-day, there is a noticeably greater number of bicycles in use in the smoother than in the hillier districts of the country; in West Lancashire as compared with West Yorkshire, for example. The great numbers of bicycles in Holland and in Denmark are

[1] There were as many as 3,000 separate components in 1927.

[2] The blast furnace is only a small one, for the quantity required by the firm would not justify a large plant.

[3] C. R. F. Engelbach, 'Problems in Manufacture', *Proc. Institution Automobile Engineers*, vol. XXVIII (1933–4), p. 7.

[4] Further reduction in costs of production might be effected if seasonal variation of output could be eliminated. This is a product partly of the British climate which cannot be manipulated, but it is partly the product of heavy demand subsequent to the annual Motor Show when new models are exhibited, a concentration of demand which can be manipulated to some degree. It might be thought that the export market would assist in smoothing out seasonal variations Export markets include Australia and New Zealand, which have the opposite seasonal arrangement of climate to Great Britain, but in their warm temperate climates private cars are used winter and summer alike, and the seasonal arrangement of sales is dominated by the date of appearance of new models. For the problem of season variations in the motor trade, see C. Saunders, *Seasonal Variations in Employment* (1936), Chapter IV. These conditions do not apply to-day.

similarly a function of their smooth landscape. The West Midlands offered advantages to motor-car manufacture as to cycle manufacture. Motor-car manufacturers require a very great number of small components, a requirement which fits in with the industrial tradition of the West Midlands. Moreover, the West Midlands region practises a large variety of industries and its labour possesses a large variety of skills which bestow on the district, and perhaps on individuals, a large degree of adaptability. This is a factor stressed by Prof. G. C. Allen;[1] on this line of argument the West Midlands present an industrial environment suitable to a new light engineering industry. Motor-car manufacture is localized in the West Midlands because of this favourable industrial environment as well as because of the presence of varied metal components. Indeed, motor-car manufacture, as an assembly industry drawing in a wide variety of materials from a wide variety of localities, has a substantial degree of mobility with regard to materials and is not tied down to a single locality. Motor-car manufacture, in fact, did originally develop at widely scattered points, for the earliest cars were the product of individual craftsmanship, and there is still a fairly wide scatter of factories. Let us consider this point a little more closely.

Cost of materials, fuel, and electricity, as a percentage of value of gross output was 51·4 per cent in 1924, 58·1 per cent in 1930, and 58·9 per cent in 1935. These proportions refer to firms manufacturing cycles as well as to those manufacturing cars. Flow methods of assembly were already established in some plants by 1924, but they had become more general by 1930; prior to the introduction of these methods the percentage of materials, fuel, and electricity presumably would have been lower. The effect of flow methods of assembly is to reduce labour costs and so to increase material and fuel costs as a proportion of total cost of production. In motor and cycle repair works, where individual treatment is unavoidable, labour costs form a very much larger and material and fuel costs a very much smaller proportion of value of gross output; materials, fuel, and electricity, contributed 41·2 per cent in 1924 and 38·1 per cent in 1935 of value of gross output. These proportions relate to repair work by the motor-car and cycle trades as a whole. In an assembly industry such as motor-car manufacture the labour costs in making components have already been incorporated and go to swell the costs of materials. The only labour costs to be met are those of actual assembly, and with flow production these are greatly reduced. The labour costs incurred in making components are incorporated into cost of materials. The proportions discussed above are not the same for each subdivision of motor-car manufacture. In so far as net output as a percentage of gross output is an index of labour

[1] G. C. Allen, *The British Motor Industry*, Spec. Mem. no. 18, London and Cambridge Economic Service (1926), p. 5.

costs, the arrangement in 1935 in ascending order of increasing labour costs was private cars, commercial vehicles, motor cycles, pedal cycles, car bodies, and accessories.[1] The construction of private cars, which involves the greatest number of vehicles, is thus the most economical of labour, and the flow system of assembly must be largely responsible. In an assembly industry of this kind, therefore, a fairly high proportion of materials costs to total costs does not imply that the industry is tied to sources of materials.

If the location of motor-car manufacture is largely independent of location of materials, it is equally independent of location of skilled labour. The proportion of skilled labour in motor-car manufacture has been estimated at under 10 per cent, which is substantially less than in engineering as a whole. The great expansion of output in the inter-war period has been based on flow production and has involved the recruitment of the semi-skilled for working 'on the line'. The assembly plant of Morris Motors at Oxford, whose relatively few key skilled men were brought from the West Midlands, recruited the mass of its labour at first from unskilled men in the town and in the neighbouring villages and later from a wide radius. In July 1936 46·7 per cent of the insured employed in the motor trades in Oxford were 'foreigners', that is, were first insured in a district other than Oxford, and at least half of these came from parts of the country where there was little or no motor-car manufacture.[2] Case-histories of Welshmen working in the motor works at Oxford make it clear that those men working 'on the line' came from other occupations.[3] Recruitment into the motor-car and aircraft trades in Greater London in the second half of 1936 was noticeably easier than into general engineering. 'Less difficulty,' say Professors Allen and Thomas, 'was experienced in placing semi-skilled and (to a less extent) skilled workers in occupations specific to motor and aircraft construction than in work common to all sections of the engineering industry.'[4] It may be, though this is not the only construction that can be placed on the above statement, that the motor trades were less difficult to please, for their requirement of initial skill was low. Motor-car manufacture could thus be set up freely in areas largely devoid of skilled engineering labour, and it is, in fact, in such areas that the industry has grown most rapidly, as will shortly appear.

These are some general factors affecting the geographical distribution of motor-car manufacture. Let us now examine the regional

[1] Net output as a percentage of gross output in 1935 was 33·2, 36·9, 41·1, 45·7, 49·0, and 54·7 per cent respectively.

[2] *A Survey of the Social Services in the Oxford District*, vol. I (1938), Chapters III and V There is a useful dot map (Fig. 22) of places of origin of all insured immigrants.

[3] G. H. Daniel, 'Some Factors Affecting the Movement of Labour'. *Oxford Economic Papers*, no. 3 (1940).

[4] R. G. D. Allen and Brinley Thomas, 'The Supply of Engineering Labour under Boom Conditions', *Economic Journal*, vol. XLIX (1939), pp. 264–5.

the most important single region, having 43·1 per cent of the total in 1930 and 36·6 in 1935. There is a much more even scatter throughout the rest of Great Britain in repair work than in manufacture. It is to be expected that the regional distribution of repair work will be roughly in proportion to the regional distribution of car and cycle ownership. It is well known that Greater London houses a larger number of cars per 1,000 of its population than any other part of the country. The distribution of private car and of goods vehicle ownership per 1,000 of the population is set out in Table LVI for the Census of Production regions. It will be noticed that the 'metropolitan' centres, London in England and Edinburgh in Scotland, have a larger share of repairing than of vehicle ownership, and that, conversely, most other districts have a slightly lower share of repairing than of vehicle ownership. Apart from these variations, however, the correspondence between the distribution of repair work and the distribution of vehicle ownership is generally true.[1] There have been significant changes, however, as between 1930 and 1935. London's percentage has declined substantially and the actual numbers employed in repair work have scarcely increased;[2] most other areas have increased both their actual numbers and their percentage. These changes are due very largely to a wider diffusion

TABLE LV

A. Regional Distribution of Motor Vehicle, Cycle, and Aircraft Trades Manufacturing and Repairing

(Ministry of Labour Returns)

As percentage of insured employed of Great Britain in mid-year

	1924	1929	1938		1939	1948	Motor & Cycle Manufacture only 1948	1950
London	17·3	16·9	20·9	London and				
South-eastern	11·8	12·4	13·0	South-eastern	24·3	22·9	24·0	21·6
South-western	8·4	11·9	14·5	Eastern	5·7	6·5	7·2	7·3
Midlands	42·8	39·6	31·9	Southern	8·0	8·0	6·8	7·5
North-eastern	5·2	5·6	4·7	South-western	9·9	7·6	2·0	1·7
North-western	8·9	8·0	8·6	Midland	25·8	23·3	35·2	37·2
Northern	—	—	1 3	North Midland	5·3	6·7	4·6	5·3
Scotland	4·6	4·7	4·2	Yorkshire	3 5	4·8	3·5	3·8
Wales	1·0	0·9	0·9	North-western	11·0	10·7	11·4	10·4
				Northern	1·5	1·7	1·1	0·9
				Scotland	3·9	5·2	3·1	3·2
				Wales	1·1	2·6	1·1	1·1
	100·0	100 0	100·0		100·0	100·0	100·0	100·0

[1] There is a wide variation in private car and goods vehicle ownership per 1,000 of the population. London stands first, and after it the residential regions of South-east and South-west England. The industrial regions are lowest in the scale, the lowest of all being urbanized coal-mining and heavy iron and steel districts like the West of Scotland and the North-east Coast. Regions which are largely rural occupy an intermediate position.

[2] 20,006 in 1930 and 20,201 in 1935.

TABLE LV (*contd.*)

B *Regional Distribution of Motor Vehicle and Cycle Trades*

(Census of Production Returns)

	Manufacturing and repairing			Manufacturing		Repairing	
	1924	1930	1935	1930	1935	1930	1935
Greater London	19·4	21·8	23·9	16·7	20·7	43·1	36·6
Lancashire–Cheshire	8·1	7·8	4·8	7·8	3·8	7·8	8·6
West Riding of Yorkshire	2·0	2·6	2·9	2·4	2·0	3·4	6·3
North-east Coast	0·5	0·9	0·9	0·3	0·2	3·9	3·5
West Midlands	50·6	45·8	45·4	55·9	55·3	3·2	5·2
East Midlands					4·2		3·8
Salop, Hereford, Gloucester					0·5		1·9
South-east	15·8	17·0	17·9	14·9	10·1	25·9	9·4
East					1·3		4·6
Rest of England					0·2		5·1
Wales and Northern Ireland	0·4	1·1	1·0	0·2	0·1	5·0	4·7
West of Scotland	1·8	1·8	1·7	1·5	1·3	3·0	3·6
East Central Scotland	1·4	1·2	1·5	0·3	0·2	4·7	4·5
Rest of Scotland					0·1		2·2
	100·0	100·0	100·0	100·0	100·0	100·0	100·0
Index numbers.							
Numbers employed (1924=100)	100	125	145	115	133	198	236
Value of gross output (1924=100)	100	131	161	126	158	189	203

of car ownership geographically as well as socially. The population of Greater London especially, and of the English Plain generally, had initially a relatively large share of cars by reason of its social composition and its smooth landscapes; the centres of population in the north and west of Britain acquired cars in quantity relatively late by reason of their rather different social composition and their hillier landscapes.

TABLE LVI

Regional Distribution of Private Car and Goods Vehicle Ownership, 1935

	Percentage of numbers employed in Great Britain on repair work	Percentage of vehicles in use		Numbers per 1000 of population	
		Private cars	Goods vehicles	Private cars	Goods vehicles
Greater London	37 5	26·1	26·8	55	17
Lancashire-Cheshire	8·8	10 2	11·8	25	8
West Riding of Yorkshire	6·4	6·1	6·5	26	8
North-east Coast	3·6	3·4	3·9	19	6
West Midlands	5·3	8·0	7·8	34	9
East Midlands	3·9	5·1	5·2	31	9
Salop, Hereford, Gloucester	1·9	3·4	2·8	43	11
South-east	9 6	12 8	10·3	47	11
East	4·7	5·7	5·7	36	11
South-west	4·5	6·7	5 6	48	12
Cumberland, Westmorland	0 7	0·7	0·6	33	9
Wales	2·6	4·2	4·4	24	7
West of Scotland	3·7	2·3	3·2	16	6
East Central Scotland	4·6	2·0	2·3	25	8
Rest of Scotland	2·2	3·3	3·1	30	8
Great Britain	100·0	100·0	100·0	32	10

Calculated from the returns of the Census of Production and from tables in *The Motor Industry of Great Britain* (1939). Northern Ireland is excluded from this table, but included in Table LV

Manufacturing and repairing thus display different regional distributions and different trends in those distributions. The percentages showing the regional distribution of both combined are uneasy approximations depending on the relative weight of manufacturing and of repairing respectively in each region. In most regional areas manufacturing employed more than repairing, but repairing was the more important on the North-east Coast, in the South-west, in Cumberland-Westmorland, in Wales, and in Scotland, apart from the West of Scotland. This is a not insignificant list, for it consists very largely of remote districts in the corners of the country. The manufacturing districts, even the minor ones, are centrally situated and are within comparatively easy access of the main centres of population. Motor-car manufacturers in a remote corner of the country would be compelled to meet high delivery

charges in respect of the thousands of components required and the average purchaser would be compelled to pay an extra charge on a mileage basis for the delivery of his car when its price is quoted *ex works*.

Although the Ministry of Labour returns include aircraft along with the manufacture and repair of motor vehicles and cycles and thus confuse the issue still further, they confirm in general terms for the inter-war period the points already made.[1] It will be noticed that the percentage of the Midlands is lower on the Ministry of Labour returns than on those of the Census of Production. The latter give an annual average of numbers employed, but the former, as quoted in Table LV, refer to a mid-year date. Motor-car manufacture had in the inter-war period a substantial seasonal rhythm, private car output varying from 50 per cent above to 50 per cent below the monthly moving average and commercial and bus output from 30 per cent above to 20 per cent below.[2] The fluctuation of employment in motor-car manufacture, it is true, is of lesser amplitude than the fluctuation of car output, but the significance of this fluctuation in the interpretation of the table is that the lowest output comes in late summer and that the returns of Table LV refer to a date in July. The Midlands, the premier manufacturing district, has a lower employment in summer than the average for the whole year.

The Industry Tables of the 1921 and 1931 Census[3] are very difficult to tie up with the employment returns of the Ministry of Labour and of the Census of Production.[4] The most important single centres, both in 1921 and in 1931, were Birmingham and Coventry, in that order. In the second rank, in 1921, were Greater Manchester, Derby, Wolverhampton and the Black Country, Luton, Nottingham, and Slough. In the third rank were smaller centres, including *inter alia* Sheffield, Huddersfield, Bradford, Southport, Leyland, Bristol. Subsequently, Oxford and Dagenham developed into centres of at least the second, and possibly of the first, rank, and Greater Manchester lost substantially by the transfer of the Ford factory from Trafford Park to Dagenham on the Thames Estuary.

[1] The actual percentages differ, however, owing to the above causes, owing to the exclusion of some workers from the scope of the Unemployment Insurance Acts and owing to the lack of exact correspondence between the boundaries of the areas drawn for the two statistical purposes.

[2] Saunders, op. cit., p. 57.

[3] The basis of the Industry Tables at the two dates is not the same. In 1921 all persons were included whether in work or not, and they were attributed to their workplace, while in 1931 only those in work were included in the industry classification and they were attributed to their place of residence.

[4] In particular they attribute a smaller percentage of the total to the West Midlands district—for the self-propelled vehicles and cycle group (manufacture and repair), 34·0 per cent of England and Wales in 1921 and 38·9 per cent in 1931. Even if motor and cycle accessories be included, the percentage becomes only 37·4 per cent in 1921 and 42·6 per cent in 1931. The West Midlands largely controls the manufacture of motor and cycle accessories, having 69·2 per cent of the total for England and Wales in 1921 and 71·0 per cent in 1931.

The position in 1938 is set out in Table LVII, which is based on private information. It refers to completed vehicles, that is, exclusive of chassis sold as such, and irrespective of horse-power. While in respect of total vehicles Birmingham remained the largest single district, the Home Counties and Oxford had developed an output slightly greater than Coventry, and Luton an output not far behind that of Coventry. These changes confirm the growth of the share of the Home Counties, Oxford, and Luton, which were in the London and South-eastern divisions of the Ministry of Labour as defined prior to 1939. The North of England and Scotland contributed only a minor fraction of the total. The district percentages, however, differ as between private cars (with taxi-cabs) and commercial vehicles (with omnibuses). Birmingham, Oxford, Coventry, and the Home Counties, have the largest output of private cars; Luton, the Home Counties, and Birmingham, the largest output of commercial vehicles. The numerical importance of Austin, Morris, and Ford makes among private cars and of Bedford trucks and Ford vans among commercial vehicles is thus demonstrated. Although these districts are of quite minor importance, it is not without significance in view of their industrialism and of their relatively low ratio of private car ownership alike, that northern England and the West of Scotland are more important in the manufacture of commercial vehicles than of private cars.

TABLE LVII

Regional Distribution of Output of Private Cars and Commercial Vehicles in 1938

District	Private cars and taxi-cabs	Commercial vehicles and omnibuses	Total
Home Counties	18·7	25·3	20·1
Luton	10·1	33·2	14·8
Oxford	22·1	11·8	20·0
Birmingham	26·9	21·7	25·9
Coventry	21·4	—	17·0
North England	0·8	5·5	1·7
Glasgow	—	2·5	0·5
Great Britain	100·0	100·0	100·0

In its initial stages of development prior to the 1914–18 war, imports of completed cars and of chassis combined exceeded exports both in numbers and in value, though the excess in value was scarcely significant.[1] In the years immediately afterwards the excess of imports in numbers of cars and chassis increased,[2] and in 1924, which was by no means an exceptional year in this respect, 14·5

[1] In 1913 retained imports were 12,993 in numbers and were valued at £3,135,000, exports were 8,829 in numbers and were valued at £2,861,000.

[2] In several years, however, exports exceeded retained imports in value.

per cent of the home market for cars and chassis (private and commercial) was supplied by imports. By 1930, however, the situation had changed. Exports substantially exceeded imports in numbers as well as in value, and in that year imports supplied only 5·1 per cent of the home market for cars and chassis. By 1935 the percentage of the home market supplied by imports had been reduced still further to 3·9 per cent. The change was due not so much to protective duties, for there had been protective duties since 1915, as to the adoption of flow methods of assembly, which have greatly reduced cost of production within Great Britain and so enabled the output of cars at prices comparable with those made abroad. The increasing volume of export is true of both private cars and commercial vehicles; private cars are exported mostly as complete vehicles, but commercial vehicles as chassis as well as complete vehicles. This export of chassis is bound up with the convenience of shipment, for a chassis occupies considerably less space in the ship's hold, and it is convenient for the user in the export market to fit the type of body most suited to his requirements. Export is primarily to the Empire, which took 86·9 per cent in 1924, 86·4 in 1929, 84·6 in 1937, and 81·2 in 1938.[1] The market is affected, however, by problems of design, as is well known. Owing to the circumstance that British taxation of motor vehicles used to fall most heavily on the higher horse-power classes, British motor engineering has developed on the lines of the small high-speed engine with a low petrol consumption which offers an additional economy in a country that imports all its petrol. Recent changes in the basis of taxation have done little to alter the position. This is quite different from American practice, American cars being of higher horse-power, but less economical of petrol. British cars, further, are designed for use on smooth British roads where a high clearance is unnecessary. It is often held that British cars are unsuited to colonial markets. For rough country the point is a valid one, but an analysis of the distribution of motor vehicles in India shows that in the early 'twenties nearly three-fifths were in three cities where roads were in existence. If this is general, it would imply that British cars designed for the British home market are suitable for town work even in colonial lands, though cars of different design would still be necessary for rough country with only earth roads or no roads at all. The future course of export of motor vehicles from Britain is difficult to forecast: it depends on the extension of smooth road surfaces in the export markets and on the extension of the purchasing power of these markets; it depends, moreover, on the competitive price, design, and quality of vehicles made in Britain. There was a large increase in export after 1945 to levels several times higher than those of 1935 for both private cars and commercial vehicles. These high levels may be due to purely temporary circumstances and their

[1] Of export in 1946, 44·2 per cent by value was to the Empire.

permanence cannot be assured. Several companies, however, have restricted the number of models in order to lower output costs.

The manufacture of aeroplanes, an even younger industry than motor-car manufacture, is still largely in process of development. Although balloons have long been made, and though the Royal Aeronautical Society was founded as far back as 1866, the Wright brothers made their first successful flight in a power-driven machine heavier than air so recently as 1903.

It will be well to examine first, as for motor-car manufacture, the characteristics of aircraft production before discussing, in the light of these characteristics, its regional distribution. In conformity with the need for material light in weight, the fuselage and wings were initially built of wood, but subsequently steel replaced wood and light alloys replaced steel. Plastics are being used increasingly for particular components, and the range of their employment will probably expand. To-day there are wooden, steel, and light alloy planes, though the wooden ones are made of plywood rather than of timber. 'It appears to be accepted that . . . a modern aeroplane could be produced equally efficiently, from aerodynamic and weight points of view, if constructed essentially of wood, steel, or light alloy.'[1] The original Wright engine was made chiefly of iron and steel, but modern aero-engines consist almost equally of ferrous metals and of non-ferrous alloys, the average of three engines on a weight basis in 1938 being 46·0 per cent ferrous metals, 53·7 non-ferrous metals, and 0·3 non-metallic minerals.[2] The industry of aircraft manufacture thus employs materials which are light in proportion to their bulk, are very varied in kind, and originate from a wide variety of sources. In many of these respects aircraft manufacture exhibits analogies to motor vehicle manufacture, but in an exaggerated form, for lightness of material, while desirable in a motor vehicle, is essential in an aeroplane. Aircraft production is similar to motor vehicle production also, in that many of its components are prefabricated elsewhere. Some firms make aero-engines only,[3] others air-screws only, and some air-frame factories are assembly plants pure and simple. The management and operative personnel of the industry are drawn largely from the motor trade and several of the factories set up prior to and during the late war were placed under the management of motor manufacturing firms. But, although aeroplane manufacture is thus in many respects comparable to and closely linked with automobile engineering, it is only just arriving at the stage of large-scale production methods. An American declared in 1938 that 'no true conveyor system such as the automobile assembly line can be found,

[1] H. J. Gough, 'Materials of Aircraft Construction', *Journal Royal Aeronautical Society*, vol. XLII (1938), p. 930.

[2] Gough, op. cit., p. 939.

[3] Of these some two-fifths are motor-car firms. Aero-engine manufacture has developed more naturally than air-frame assembly out of motor-car manufacture.

nor is it warranted yet'.[1] Increased bulk orders during the war have alone made possible the adoption of such assembly lines.[2] Manufacture has developed on lines of sub-assembly (that is, of fuselage and of wings separately, sometimes of different parts of fuselage and of wings separately), the whole being brought together in final assembly to form the finished craft. Work on each part takes longer than on a car, and assembly line methods are certainly more difficult to organize. There was much interest in systems of assembly beginning to develop in the years immediately preceding the late war, when aircraft orders were becoming sufficiently large to justify its consideration.[3] The aircraft industry during the late war was going through a phase similar to that experienced by the automobile industry about 1924.

As air-frame construction involves thousands of components whose assembly requires the employment of large quantities of labour, the cost of materials, fuel, and electricity contributes comparatively little to gross output, the percentages being 31·9 in 1924, 33·0 in 1930, and 37·3 in 1935. It is an industry with a high degree of mobility and with a large variety of sites open to it. It will be noticed, however, that some increase in the percentage of materials, fuel, and electricity, has developed, an increase which may be attributed to more carefully elaborated systems of sub-assembly and to the increased scale of output.[4] It is significant that the increased percentage came chiefly with the more rapid growth and increasing size of establishment after 1930.[5] In motor-car production the increasing percentage of costs of materials, fuel, and electricity (and the complementary decrease of labour costs as a percentage of gross output) came between 1924 and 1930, when production systems were similarly being reorganized and the volume of output increased.

After this discussion of the character of the industry, let us now turn to its geographical distribution. In 1935 Greater London had 37·2 per cent of the total numbers employed in aircraft manufacture in Great Britain; Greater London, the South-east, and the East areas of the Census of Production had in the aggregate 54·6 per cent of the total. Over half of the industry in 1935 was thus concentrated in the Home Counties, using the description in a wide sense, or, to give the area an alternative name, in Metropolitan England. This

[1] T. P. Wright, 'American Methods of Aircraft Production', *Journal Royal Aeronautical Society*, vol. XLIII (1939), p. 143.

[2] The first instance in Britain was a trainer built by Phillips and Powis (*Aircraft Production* (Oct. 1940), p. 310).

[3] The 1939 volume of the *Journal of the Royal Aeronautical Society* has many references to these problems of production; previously interest had been primarily in design. The publication *Aircraft Production* was founded in the early years of the war.

[4] For an illustration of this point, see Wright, op. cit., p. 133.

[5] Gross output was £4·6 million in 1924, £8·7 million in 1930, £13·9 million in 1935. Average number employed per return was 587 in 1924, 561 in 1930, and 715 in 1935.

concentration had been more pronounced previously, for Greater London itself had had 41·7 per cent of the total numbers employed in 1924 and 46·3 per cent in 1930. Metropolitan England, in which aircraft manufacture was originally centred, has thus ceased to be so predominantly its focus as the industry has grown: aircraft manufacture has expanded in space as well as in bulk. There are large plants in the West of England (at Bristol, near Gloucester, and at Yeovil), in the West Midlands (at Coventry and Wolverhampton), and in the North of England (in Greater Manchester, at Leeds, and at Brough on the Humber Estuary), as well as in Greater London, at Rochester, Southampton, Portsmouth, and Cowes. These were the air-frame factories in operation before the setting up of shadow factories with rearmament prior to the 1939–45 war. These shadow factories corrected still further the concentration of production on Metropolitan England, a target area in time of war, for they were still more widely dispersed. Some of these war-time factories have already been converted to other industrial usage. The distribution consequential on renewed rearmament has yet to appear.

Air-frame assembly plants have tended to develop in relatively open country either on the outskirts of the towns or in purely rural districts. Existing factory premises in built-up areas almost invariably are wholly unsuited; the assembly shop needs to be of large dimensions both horizontally and vertically, and must nearly always be built specially for the purpose. Shipbuilding, which makes even bigger craft, is done in open yards. A large open site and solid foundations are essential. It is also necessary that an aerodrome should be adjacent, for finished aircraft have to be tested before delivery. For those shops that make seaplanes and flying-boats a site adjacent to sheltered estuarine waters is required. The attraction of the smooth landscapes of the English Plain is thus fully understandable. Together with the topographically similar West Midlands, the English Plain, moreover, has the greater number of motor vehicle plants and has all the larger establishments; they have thus the kind of engineering labour which aircraft factories require. Motor vehicle manufacture originated in the West Midlands and later spread into the Metropolitan area; aircraft manufacture originated in the Metropolitan area and later spread into the West Midlands, the West of England, and elsewhere. As the market for aircraft expanded, the industry became more widely diffused. All assembly shops, however, are in relatively smooth country in whatever part of Britain they occur.

The attraction of suitable labour and of a topographically suitable site would thus appear to be a more important factor in determining location than that of materials. The effect of aero-engine, air-screw, and aircraft component manufacture on the location of air-frame assembly does not appear to be profound: the value of their products

is so great in proportion to their bulk. Apart from those firms which construct both engines and aircraft, aero-engines are made chiefly in the West Midlands, in Greater London, in the West of England, and in the North of England, as at Derby and Crewe. This distribution is not dissimilar to that of air-frame assembly. Air-screw manufacture has a westerly focus, with half a dozen firms in the lower Severn Valley to four in Greater London. The manufacture of aircraft components other than aero-engines and air-screws is widespread. The largest number of firms—about two-thirds of the total—is shared equally by the West Midlands and by Greater London, but the West of England, the West Riding, Lancashire, and even Scotland, are also involved. Judging by the character and location of the firms involved, it would appear that Sheffield supplies much of the steel, Leeds many of the bolts and screws, and Halifax much of the wire. Metal industries in these centres supply engineering establishments of all kinds in addition to air-frame assembly.

IV

ELECTRICAL ENGINEERING

The electrical trades constitute the last of the engineering group of industries to be considered in this chapter. These electrical trades are very diverse and the term 'electrical engineering' may be employed in both extended and strict senses. The Ministry of Labour uses the term in a strict sense and separates electrical cable, wire, and electric-lamp manufacture from electrical engineering, but the Census of Production uses the term in an extended sense and includes these under the description 'The Electrical Engineering Trade'. The problem is by no means merely classificatory, for there are differences in location, as will appear shortly.

Taking all branches together in the widest sense of the term, electrical engineering is in some ways comparable with, and in some ways different from, the engineering industry as a whole. Equally with engineering shops, factories making electrical equipment depend largely on electricity generated outside the establishment, the purchases of fuel and electricity being in the proportion of 4 to 6 as compared with 4½ to 5½ in total engineering. Cost of materials, fuel, and electricity constituted 46·1 per cent of the value of gross output in 1935: the equivalent figure for all engineering was 48·8 per cent. Electrical engineering is thus comparable to other engineering trades in these respects. They imply a large degree of mobility in factory location. As the proportion of total costs contributed by materials, fuel, and electricity is decreasing, having been 51·8 per cent in 1924, 48·5 in 1930, and 46·1 in 1935, it may be held that the degree of mobility is increasing, though the change is within a condition presenting a large degree of mobility at the outset. Total engineering has

exhibited a trend in the same direction though of lesser amplitude. Most industries, in fact, exhibit this trend: the chief exceptions are those which are reorganising methods of production, such as air-frame assembly. Electrical engineering, however, does not replicate all the qualities displayed by engineering in its total sense. Like aircraft manufacture, but unlike most forms of mechanical engineering, the electrical trades use non-ferrous metals more extensively than iron and steel; of the total weight of metal employed in 1935 three-fifths were non-ferrous. Further, while of the total number insured, according to the Ministry of Labour returns for July 1948, the percentage of women was only 10·2 in mechanical and 9·0 in constructional engineering, 3·5 in shipbuilding and repairing, 13·5 in vehicle manufacture and repair; it was 28·3 in electrical machinery, 38·6 in electric wires and cables and 54·4 in valves and lamps.[1] Many of the electrical trades, therefore, are independent of iron and steel centres, and, being able to employ women in large numbers, may thus be drawn to areas where female labour is available.

The regional distribution of the electrical trades in their total sense is set out in Table LVIII. It is at once clear that there are three primary centres—Greater London, Lancashire, and the West Midlands. Between them they were responsible for 85·2 per cent in 1924 and 85·4 per cent in 1935 of the total numbers employed. The same three districts had 53·4 per cent in 1924 and 61·9 per cent in 1935 of total numbers in all engineering trades. They thus have a greater relative share of electrical than of total engineering. It is Greater London, however, that has such a large excess share of the electrical trades and London is their chief single centre. This is not true of each individual branch of electrical engineering. It is most pronounced in wireless apparatus and electric lamps, London and the South-east having no less than 59 per cent of all at work in those trades in 1948. The Eastern region had an additional 18 per cent of the wireless trade. The making of electrical machinery is more widely dispersed and is much more nearly correlative with the general engineering districts, particularly the West Midlands and Lancashire. The same is true of telephone apparatus. In these the South-east has no more than its share of all engineering which itself is less than its proportion of total population. Although the largest individual centres are Greater London, Greater Manchester, Birmingham, and the Black Country, Rugby, Merseyside, and Coventry, there are many others of lesser size, such as Tyneside, Nottingham, Derby, Oldham, Norwich, Leeds, Bradford, Brighton, Clydeside, and St. Helens, and, of still lesser dimensions, almost every industrial and many county towns. The list includes places of very varying

[1] These represent increases in percentages as compared with 1939. The increase had been still more pronounced during the war of 1939–45 and had then been almost double the pre-war quantities. It is greatest of all, of course, in the lighter engineering trades.

TABLE LVIII

Regional Distribution of the Electrical Trades

A

(Census of Production)

	Electrical engineering				Total engineering	
	Percentages of Great Britain			1935 as per cent of 1924	Percentages of Great Britain	
	1924	1930	1935		1924	1935
Greater London . .	41·3	40·3	46·1	184	17·4	25·3
Lancashire–Cheshire .	25 6	23·6	19·6	126	18·4	15·1
West Riding . .	1·9	1·9	2·3	198	7·4	6·0
North-east Coast .	2·0	3·0	2·4	201	8·0	4·6
West Midlands . .	18·3	20·7	19·7	177	17·6	21·5
Rest of England . .	8·5	9·1	8·4	162	16·3	17·5
Wales . . .	0·3	0·1	0·2	84	1·4	0·9
Scotland . . .	2·1	1·3	1·3	104	13·5	9·1
Great Britain . .	100·0	100 0	100·0	165	100·0	100·0

B

(Ministry of Labour)

	Percentages of insured employed in Great Britain					
	1939			1948		
	Electrical machinery	Other electrical apparatus	Total engineering	Electrical machinery	Other electrical apparatus	Total engineering
London and South-eastern .	19·0	55·7	20·0	19·4	46·2	21·6
Eastern . . .	7·1	4·7	4·4	5·9	4·4	5·5
Southern . . .	3·2	2·8	5·8	1·7	2·7	5·3
South-western . .	1·0	0·6	6·2	1·6	1·7	5·7
Midland . . .	29·8	12·4	15·1	24·9	15·1	14·0
North Midland . .	2·8	3·4	6·6	3·7	3·2	6·7
East and West Ridings .	4·7	1·1	8·5	7·3	1·4	7·5
North-western . .	21·6	17·5	14·4	23·3	18·1	15·1
Northern . . .	7·0	0·4	7 5	8·0	2·3	6·8
Wales . . .	0·5	0·5	1·2	0·8	2·4	2·1
Scotland . . .	3·3	0·9	10·3	3·4	2·5	10·2
Great Britain . .	100·0	100·0	100·0	100·0	100·0	100 0

character, and it includes many centres which are not industrial towns in the ordinary connotation of the term. The electrical trades, like engineering in general, are widely dispersed. It is noticeable, however, that important mechanical engineering districts, such as

the West Riding, the North-east Coast, and Clydeside, have only a small share of the electrical trades. Within the general engineering framework they have a different regional emphasis and they display more comparability to the motor and aircraft trades than to the general machinery and shipbuilding trades. This different regional emphasis is due partly to their greater affinities with motor vehicles and aircraft, both of which employ electrical equipment, but it is due also to the circumstance that these are new industries and have tended to develop especially in new types of industrial location which display two sets of qualities: (*a*) they are accessible centres, where the varied components can be readily assembled and from where the finished product can be easily dispatched, rather than remote corners of the country, and (*b*) they are frequently large conurbations where a large market for what were initially luxury articles is close at hand, and where a large volume of labour is available. The 'heavy' engineering industries are correlative in their distribution with the mechanical industries for which they make machines, and these mechanical industries are themselves very largely on the coalfields: the 'light' engineering industries are correlative with the consuming public which is ubiquitous with the distribution of population, though there are regional variations in the precise quantities of light engineering products consumed per head.[1]

[1] The precise distribution of electrical engineering is not static. It has tended to change with shifts in total population: thus the percentage of the older industrial centres has tended to decline and the percentage of the newer, especially Greater London and the South-east, to increase. In the inter-war period Lancashire–Cheshire thus had had a decline in its share of electrical engineering, a smaller decline in its share of total engineering and a still smaller decline in its percentage share of all insured employed. But these trends were halted during the war. The percentage of the south-east districts declined and that of most other districts increased. This increase was most pronounced in those areas which had had little electrical engineering previously, that is, those described as Depressed Areas in the 'thirties and those which constitute the Development Areas of to-day. In this can be discerned first, the search for labour during the war and, second, the effects of government policy towards the location of industry.

CHAPTER IX

WOOL TEXTILE MANUFACTURE

I

THE FACTORS AFFECTING LOCATION

THE woollen and worsted, as the textile industries generally, present rather different problems of location from the metal industries considered in the previous chapters. The metal industries may exhibit a wide range in degree of mobility between the immobile blast furnaces set up on the site of ore or of coal and the shops making finished articles diffused in consuming districts or set up in specialist manufacturing regions, but the initial processes are securely tied down to the raw materials employed. The textile industries are much less dependent on the location of their raw materials; there are textile industries in the vicinity of raw materials, it is true, but they are by no means tied down and limited to such localities. This locational independence of raw materials may be attributed to the substantial value (£130·7 per ton in the case of raw wool in 1935) and to the small weight (1·9 tons of raw wool and other textile materials per annum per person employed in the case of the woollen and worsted industries) of the raw material employed. The quantity of wool employed presents no severe transport problem and, value in relation to bulk being high, it can bear transport charges without difficulty. In these respects textile manufacture is comparable more to engineering than to pig iron and steel manufacture.

The location of the textile industries is affected much more profoundly (*a*) by the conditions required for, and (*b*) by the other materials employed in, the course of the manufacturing process. Textile manufacture requires a high degree of humidity in order to limit breakages of the roving being spun and of the yarn being woven. The textile, but especially the woollen and worsted industries, require also substantial quantities of water of a low degree of hardness for process work and for steam-raising. It has been estimated that in the latter half of the nineteenth century the amount of water required for industrial purposes in Lancashire and Yorkshire was equivalent to 8–10 inches of rainfall on the gathering grounds of the Pennine watershed.[1] A bleaching, dyeing, and printing works, for example,

[1] Evidence of J. R. Davidson before the Joint Committee on Water Resources and Supplies (*Minutes of Evidence*, Session 1935–6, Q. 568). As 'the available annual rainfall was from 24–30 inches', the industrial requirement of 8–10 inches worked out at one-third of the total *available*, and this was the proportion allotted as compensation water by waterworks authorities impounding water in the moorland valleys on the watershed.

uses for process work 1–2 million gallons per day.[1] Climate and surface geology thus act as locational factors. The textile industries, moreover, consume large quantities of coal. In the woollen and worsted industries of Great Britain the weight of coal used is nearly four times the weight of all textile materials, and the cost of this coal in 1935 was £0·8 per ton, as contrasted with £130·7 per ton for raw wool. In respect of weight and of value of raw materials, therefore, coal is likely to exert a more powerful influence than raw wool as a location factor. The textile industries generally draw on the grid for power, as distinct from lighting, to only a limited extent, and they tend to be located relatively close to coal supplies. This tendency is heightened as the present distribution pattern was evolved during the nineteenth century, when boiler efficiency was less than to-day, and when still larger quantities of coal would be required to work a given amount of raw wool.

What is the bearing of the location of raw wool supplies on the location of the woollen and worsted industries within Great Britain? The location of the home wool clip had little relationship to the location of manufacture in 1800, but the distribution of the home clip is changing and is now associated more closely than in 1800 with northern and western districts, where the industry came to be primarily located during and since the Industrial Revolution. These shifts in the location of the home clip, however, are subsequent to the development of the present distribution of wool textile manufacture, and, except perhaps in the case of the Tweed Valley industry, are not its cause. Nor has imported wool any influence, for the wool textile industry is not located at or near the ports. It is independent of the location both of home clip and of the channels through which the imported clip arrives. Although more marked in the factory industry than in the domestic phase of manufacture, this relative independence of source of raw wool supply has long characterized the industry. The ports did not develop cotton or wool industries, despite their function as channels for the import of raw cotton and of raw wool. It is true that in the course of the nineteenth century they developed large port flour-milling and sugar-refining industries on the basis of imported materials, but grain and raw sugar are commodities of an entirely different order from raw cotton and raw wool, being of much lower grade and much bulkier in proportion to value.

The second locational factor to be discussed is that of water supply. The amount of water available is a function of the rainfall and of the character of the rock surfaces on which the rain falls; the quality of the water is a function of the character of the rock and of the depth below the surface from which the water is drawn. Dr. F. H.

[1] Memorandum of the Federation of British Industries and Imperial Chemical Industries to the Joint Committee on Water Resources and Supplies (*Minutes of Evidence*, Session 1935–6, p. 79).

Edmunds of the Geological Survey has drawn up a useful, though generalized, map dividing England and Wales into three zones:

(*a*) The English Plain (lying east of a line drawn between Scarborough and Lyme Regis, but with an embayment to include Worcestershire) draws its water from underground sources, or, in the case of London, Norwich, Oxford, Reading, Worcester, and Northampton, from surface rivers.

(*b*) The hilly South-west Peninsula, Wales, the Pennines, and the Lake District draw their supplies from surface water.

(*c*) The intermediate areas draw their supplies from both surface and underground sources, including gravitation supplies from reservoirs in (*b*).[1]

These generalized distinctions have some bearing on the general distribution of the woollen and worsted industries. There are very few wool textile factories south-east of the Jurassic escarpment in the area whose water is drawn primarily from underground sources; rainfall being low, water is in relatively short supply and, being drawn from depth, is commonly hard.[2] Industries requiring large quantities of soft water would thus operate under substantial disadvantages in this zone. The chief sites of woollen and worsted factories to-day lie in zone (*b*), whose supplies are drawn primarily from the surface: rainfall being heavy, water is abundant and, being drawn very largely from moorland surfaces, is commonly soft. These regional differences, of course, are not absolute and are capable of being diminished by the efforts of public water supply undertakings in increasing the volume of supply and in altering by treatment its chemical constitution. It may be objected that the English Plain was the main seat of woollen and worsted manufacture in the Middle Ages and prior to the Industrial Revolution, and that these alleged disadvantages of water supply cannot then have acted as a deterrent. The wool textile industries of the English Plain at that time, however, were operated on a small scale: the surface streams then drawn upon, though restricted in volume, were more nearly sufficient for industrial use than they would be to-day. Moreover, spinning and presumably the wool scouring and washing preparatory to spinning, were rural occupations even when weaving was an urban craft and the walk-mills and fulling stocks had a similarly rural distribution. Water was thus required only in small quantities by small scattered units and the problems of bulk supply did not arise.[3] The location of the

[1] F. H. Edmunds, 'Outlines of Underground Water Supply in England and Wales', *Trans. Institution of Water Engineers*, vol. XLVI (1941), pp. 15–104.

[2] Sample analyses are: chalk (22 sample localities), 24·9 parts per 100,000; Oolite (31 localities), 19·2; Bunter (17 localities), 21·3. The Bunter lying north-west of the Jurassic, has thus a hardness comparable to that of the chalk and Oolite. These are analyses on Clarke's Scale.

[3] Whether the water available would be less hard than at present is very difficult to say, though being then very largely surface run-off it might be expected on general

industry in the English Plain, in fact, was due to a relatively more advanced cultural equipment rather than to any absolute favourability of physical environment.

The water supplies of West Yorkshire, the largest wool textile manufacturing region of Great Britain, merit further analysis. The surface rocks comprise Millstone Grit and Coal Measures. The Millstone Grit is porous only in its weathered outcrop: 'the porous rock near the surface performs the function of a highly absorbent catchment and reservoir of limited capacity'.[1] It holds water at the surface and gives an abundant surface supply. On the chalk and Oolite running water is limited to the valley bottoms, but on the Millstone Grit running water is spread over the whole surface, over the hillsides as well as on the valley floors. This has been of great significance in modelling the wide diffusion of the industry over the West Yorkshire region. Indeed, in its domestic phase prior to the Industrial Revolution it was not the valley bottoms but the hillsides with a run of water at every house which were the sites of manufacture. Many valley floor settlements of to-day represent a downhill migration during the Industrial Revolution from the hillside above: thus Sowerby Bridge succeeded Sowerby and Hebden Bridge succeeded Old Town and Heptonstall. The Coal Measures consist of alternating grits and shales, in each case the water being held close to the surface. The Coal Measure country thus presents similar characteristics to the Millstone Grit country in respect of surface availability of water, and the wool textile industry has been in the past, and is at the present, widely scattered over its surface. In sharp contrast to these are the adjacent formations of the Carboniferous Limestone, the Magnesian Limestone, and the Bunter. The Bunter and Magnesian Limestone are porous: Kendall prints eighteen analyses of the Bunter, which give an average porosity of 20 per cent and eight analyses of the Magnesian Limestone which give an average porosity of 8 per cent, as compared with 2–3 per cent from a bore in the Millstone Grit.[2] Carboniferous Limestone is not in itself porous, but it is broken by joints and solution holes which swallow surface water. These adjacent formations thus present dry surfaces and an absence of surface water, which is all the more striking in contrast to the abundant surface water of the Millstone Grit and Coal Measures.

grounds. River water to-day in chalk country, however, is scarcely less hard than water drawn from the chalk by wells and boreholes, being 21·7 parts (8 analyses) and 24·9 parts (22 analyses) per 100,000 respectively. The industry on the pure chalk, however, declined relatively early.

[1] P. F. Kendall, 'The Porosity of Rocks', *Trans. Institution of Water Engineers*, vol. XXVI (1921), p. 30. The low porosity of the unweathered Millstone Grit is unexpected for the weathered outcrops display an extremely open texture. The open texture of the weathered outcrop is due entirely to the removal of cementing materials and to the destruction of felspar.

[2] Kendall, op. cit. The porosity of the chalk is 33.1 per cent (11 analyses) and of the Great and Inferior Oolite 21.0 per cent (22 analyses).

The Millstone Grit yields water not only of great abundance at the surface, but also of marked softness. It is peculiarly devoid of lime, and this is responsible in part for the agricultural poverty of the soil as well as for the softness of its water. Although hardness increases with depth, even water from deep bore-holes is only moderately hard. Much of the stream and river water and practically all the water impounded in the reservoirs in the Millstone Grit area is drawn from the peat-covered moorlands which blanket the grit along the watershed. This water is exceptionally soft and gravitation supplies from the reservoirs often require treatment for plumbo-solvency before being passed into the mains. The average hardness for twenty reservoirs is only 3·5 parts per 100,000. The water, both surface and underground, from the Coal Measures, though very variable, is usually harder than that from the Millstone Grit, but surface waters analysed are usually drawn from agricultural land and have some agricultural lime in solution. Analyses of river waters are of value for the present purpose only in the upper reaches, for the lower courses of the rivers frequently carry much trade effluent which alters their chemical character. In the upper reaches the rivers from the limestone have a greater hardness than the rivers from the grit: the upper Wharfe has 11 parts per 100,000, the upper Calder has 6.

The third factor to be considered is that of relative humidity. There are some data of actual relative humidities in textile-mills under working conditions, and it will be well to examine these first, before considering atmospheric relative humidities out-of-doors. It is clear from the Factory Inspectors' statistics, the Factory Inspectors being charged by Act to administer regulations on artificial humidification, that only cotton weaving, flax spinning, and linen weaving are deeply involved in artificial humidification, and it is significant that detailed inquiries have been confined to these industries.[1]

Cotton-spinning rooms are maintained at high temperatures of 70°–80° F., but their relative humidity need not exceed 60 per cent. The higher temperatures are required for spinning the finer counts. The need for high humidities in cotton weaving is exaggerated by the amount of size in cotton yarn of the coarser counts, for the air must be kept exceptionally humid to prevent this drying and therefore impeding the weaving of dhooties and similar low-grade cloths. The extent of artificial humidification has long been much less in the Burnley, Nelson, and Colne districts than in the Blackburn district owing to the different kinds of cloth woven, being from

[1] Departmental Committee on Humidity and Ventilation in Cotton Weaving Sheds, *First Report and Minutes of Evidence* (1909), Cd. 4484 and 4485; *Second Report and Minutes of Evidence* (1911), Cd. 5566. S. Wyatt, *Atmospheric Conditions in Cotton Weaving*, Report no. 21 (1923) (Industrial Health Research Board). H. M. Vernon, 'Recent Investigations on Atmospheric Conditions in Industry', *Journal Industrial Hygiene* (1922).

better-quality yarns and containing less size.[1] Wyatt's investigations embodied in Table LX show that actual humidities in cotton-weaving sheds, though they range widely and in some sheds fall below 70 per cent, average 75–77 per cent. Shed J is a non-humid shed acting as a control, and its humidity is that of the atmosphere: this reading falls below the general level. Witnesses before the Departmental Committees were of the opinion that a relative humidity of 77–80 per cent in one case, and of 75–80 per cent in another case, was the level desirable, but the second witness admitted that he had had no complaints from weavers of undue breakages when the relative humidity was 71 per cent with a dry bulb temperature of 80°F. It may be assumed, therefore, that a minimum relative humidity of 70 per cent is required, higher in mule spinning than in ring rooms.[2]

TABLE LIX

Extent of Artificial Humidification in Textile Factories

	Numbers employed in humid factories as percentage of total number employed in the industry		
	1898–9	1901	1904
Cotton spinning	3·7	4·5	—
Cotton weaving	34·2	37·2	39·2
Woollen spinning	1·5	2·7	—
Worsted spinning	5·6	6·7	—
Silk spinning	1·8	2·5	—
Flax spinning	27·4	28·2	29·1
Linen weaving	23·8	25·8	26·2

Calculated from the *Fourth and Fifth Annual Returns* and from the *First and Second Triennial Returns* of Persons Employed in Textile Factories.

No comparable investigation of humidities under actual working conditions in the wool textile trades has been made, and it is clear from Table LIX that 'steaming' is not practised so extensively. Yet there is some artificial humidification, and it is clear that humidities can and may fall too low. At the beginning of this century, at any rate, there were very significant differences between different parts of England in the extent to which artificial humidification was employed in woollen and worsted spinning. In the West Riding in 1901 only 1·9 per cent of the numbers employed in the wool textile trades were in humid factories, but the percentage in Nottingham was 80·0, in Derby 39·8, in Durham 52·2, in Warwick 15·8, and in

[1] *Annual Report* of the Chief Inspector of Factories and Workshops for 1906, Cd. 3586, pp. 116–17; *Second Report* of Departmental Committee on Humidity and Ventilation in Cotton Weaving Sheds (1911), Cd. 5566.

[2] For a recent review of the evidence see *Fourth Interim Report* of the Joint Advisory Committee on the Cotton Industry (1947).

Leicester 6·6. The western district has scarcely any humid factories at all. Within the West Riding the Bradford district had relatively more humid mills than the Halifax and Huddersfield districts lying farther west; in 1898–9 the difference between them had been more pronounced, 3·3 per cent of the operatives in the Bradford district being in humid factories, but 1·2 per cent in the Halifax and 1·0 per cent in the Huddersfield districts.[1] Nevertheless, these differences within the West Riding are small and must not be overstressed. Let us now consider the extent to which these regional variations within the wool textile industry in the use of artificial humidification reflect differences in atmospheric relative humidity of the open air.[2]

TABLE LX

Actual Relative Humidities in Cotton Weaving Sheds

Shed	Winter			Summer		
	Dry bulb	Wet bulb	Relative humidity	Dry bulb	Wet bulb	Relative humidity
A	70·7	65·8	76·0	72·7	68·7	80·5
B	65·5	62·2	83·0	77·5	73·4	81·5
C	72·9	68·7	79·5	76·1	71·8	80·5
D	69·1	63·7	73·0	75·3	67·8	66·0
E	70·9	65·5	73·5	71·3	64·8	69·0
F	71·6	64·6	67·0	—	—	—
G	74·3	71·1	85·0	—	—	—
X	—	—	—	75·5	73·3	90·0
J	—	—	—	72·1	62·8	57·5
Average A–E	69·8	65·2	77·0	74·6	69·3	75·5

Dry bulb and wet bulb readings from S. Wyatt, *Atmospheric Conditions in Cotton Weaving*, Report no. 21 (1923). Relative humidity read off from *Hygrometric Tables* (M.O. 265).

If 70 per cent be taken as the minimum level of relative humidity suitable for textile work, then this is experienced everywhere in Great Britain in the winter, and even in summer during the night. It is only daytime summer humidities which fall below the required level. The Departmental Committee recognized the hot days of summer as the problem. The first point to notice in the regional distribution of relative humidity is that coastal sites exhibit a very much smaller range of relative monthly humidity than inland sites.

[1] Calculated from the Supplement to the *Annual Report* of the Chief Inspector of Factories and Workshops for 1902, Cd. 1979 (1904).

[2] The relative humidity readings taken outside the mill in the open air are not immediately applicable to the conditions within the mill itself, for the air inside is invariably, even in summer, warmer than the air outside, being approximately 20° F. higher in forty-one sheds during June–August in 1910. The same absolute humidity, therefore, will give a lower relative humidity inside than outside. The need for artificial humidification is thus likely to be greater rather than less than is indicated in what follows.

Of the stations recorded in the Meteorological Office averages,[1] most of those with a coastal site have no month with an average relative humidity at 1 p.m. below 70 per cent; inland stations in contrast have three to seven months below 70 per cent at that hour, those in the English Plain having the longest periods.[2] It is, of course, during the summer months when the relative humidity of inland stations falls below 70 per cent. This coastal quality of low range is limited to a band immediately adjacent to the coast and only a few miles deep.[3] It does not characterize a region and does not appear ever to have been *per se* the localizing factor responsible for a textile industry. Let us, therefore, turn to the inland stations. Among these the chief variations are between the English Plain and the rest of the country. They are displayed graphically in Fig. 56, which shows the extent to which relative humidity falls below 70 per cent at 13 h. (1 p.m.), in July; the areas which have the greatest deficiencies of all are London and the Thames Valley. The higher elevations within the English Plain have rather a higher relative humidity, partly because of their lower temperatures. The English Plain is thus least suited in respect of the humidity factor for the practice of a textile industry. With the English Plain should be coupled the southern part of the Welsh Border and the West Midlands.

Beyond the English Plain and its borders differences in relative humidity are of a comparatively minor order. Fig. 57 sets out monthly relative humidities at 9 a.m. G.M.T. for the period 1921–35[4] for Kew in the English Plain, for Renfrew in the West of Scotland, for Manchester and Burnley, and for three West Yorkshire stations (Bradford, Halifax, and Leeds).[5] Renfrew has a somewhat higher humidity than the average for the four Lancashire stations, but its cumulative deficiency below 70 per cent for the summer months is identical. In fact, Stacey picked out the western slopes of the Southern Pennines, after Princeton on Dartmoor, as the most humid part of the whole of England and Wales. The Yorkshire stations have a lower level of relative humidity than Lancashire or the West of Scotland

[1] *Averages of Humidity for the British Isles* (1938), M.O. 421.

[2] This difference between coastal and inland stations was noticed by W. F. Stacey in 1915. He elaborated further differences between coast and inland stations based on 9 a.m. readings for a ten-year period, but these additional differences are not displayed in the 1 p.m. readings for a more extended period as given in M.O. 421 (1938) (W. F. Stacey, 'Distribution of Relative Humidity in England and Wales', *Journal Royal Meteorological Society* (1915)).

[3] Higher relative humidities at coastal stations at midday in summer are the product of lower midday temperatures and of the transfer of sea air on to the land owing to the operation of the daytime sea breeze circulation.

[4] The only exception is Leeds, whose period of years is 1923 to 1935.

[5] The sources of the Kew, Renfrew, and Lancashire returns are given in the footnote on p. 466. For the West Yorkshire returns, I am indebted to the Medical Officer of Health of Leeds, to the librarian of Halifax, and to the Park Superintendent of Bradford. I have also been allowed to consult the records of Mr. D. A. Lord of Todmorden referring to a shorter term of years; they place Todmorden intermediate between the Lancashire and the West Yorkshire set.

in all months except May and June, and also a greater cumulative deficiency below 70 per cent. Although presenting a higher level and a lesser cumulative deficiency than the English Plain, the

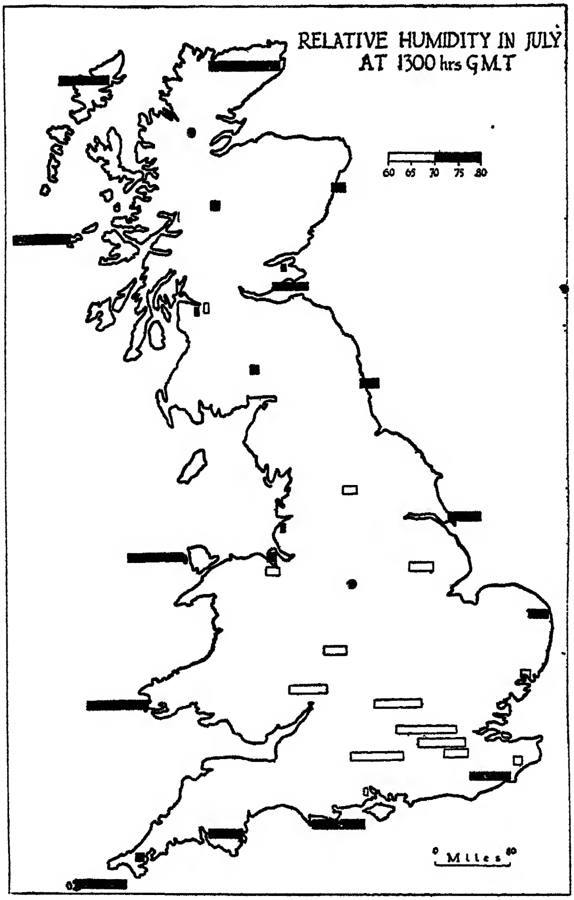

Fig 56

RELATIVE HUMIDITY IN GT. BRITAIN IN JULY AT 1300 HRS. G.M.T.

Drawn from data in *Averages of Humidity for the British Isles* (1938) M.O. 421. The averages mostly refer to the fifteen years, 1921–35. Relative. Humidity in July at 1 p.m. is close to the (average) minimum for the whole year. The length of the bar is proportional to the deviation at each station from a relative humidity of 70 per cent, being shaded above that level and unshaded below it

Yorkshire curve is of an eastern rather than of a western type. These differences between the eastern Lancashire and the West Yorkshire stations are in harmony with the more easterly position of the latter

on the lee-side of the Pennine watershed. The western parts of the West Yorkshire region, however, have humidities more nearly approaching those of eastern Lancashire, Leeds and Bradford being topographically more open than the confined and wetter valleys of the western parts represented by Halifax and Todmorden. The curve for Wakefield for the period 1901–10 is very similar to that of Leeds for the same years, and the two places have similar positions.

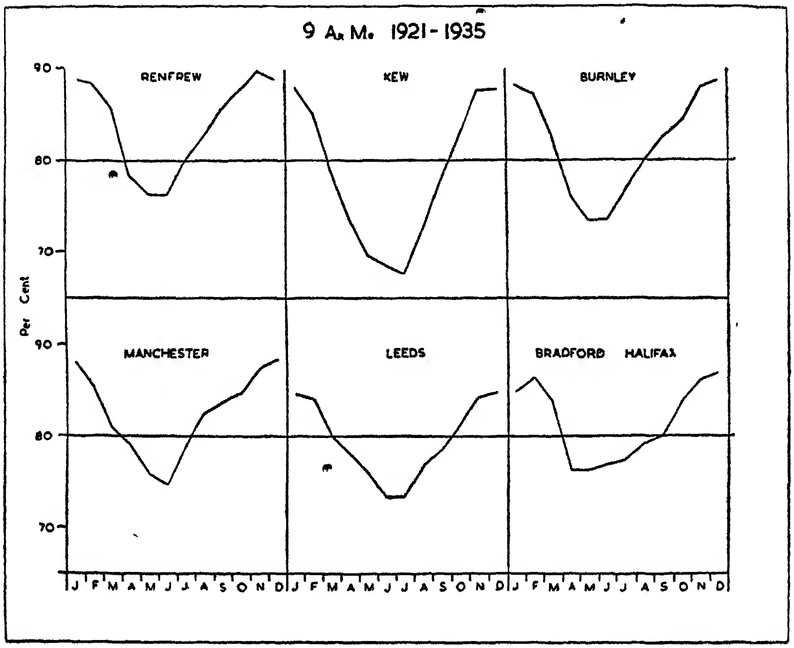

Fig. 57

AVERAGE MONTHLY RELATIVE HUMIDITY FOR SIX STATIONS IN GREAT BRITAIN AT 0900 HRS. G.M.T.

The six stations are *Renfrew* in the West of Scotland, *Kew* in South-east England, *Burnley* and *Manchester* in Lancashire, *Leeds* and *Bradford–Halifax* in West Yorkshire. The curves have been drawn from averages for identical years, 1921–35. Relative humidity at 9 a.m. is near to the maximum for the day. For sources see footnotes on pp. 422 and 466.

The difference in humidity is paralleled by a difference in rainfall, for, while Manchester has an annual rainfall of over 30 inches and most Lancashire cotton towns of over 40 inches, Leeds and Wakefield have 25–26 inches and only Halifax and Huddersfield, farther west, have well over 30 inches.

The effect of the water and of the humidity factors on the location of the woollen and worsted industries on the scale at which they are developed to-day is thus to favour districts in the north and west

of Britain, external to the English Plain. The effect of the location of raw wool supplies may appear to favour the northern and western districts also, but its influence is not profound. The coal factor again favours districts in the north and west so long as the woollen and worsted industries continue to rely on the steam-drive generated from coal-fired boilers. But as between one coalfield and another in northern and western Britain, there is little to choose on the ground of humidity and little more on the ground of water or of raw wool. The segregation of the wool textile industries into *particular* districts within this territory is the result of other than direct physical factors—the presence or absence of traditional wool textile industries prior to the Industrial Revolution and the competition between different kinds of industrial employment for the labour and inventiveness available in the district.

II

REGIONAL ANALYSIS OF THE INDUSTRY

After this discussion of the factors affecting the location of the industry, let us now analyse the distribution of the industry within Great Britain.

The Census of Production returns give a general view of the relative bulk of production in the several major regions of the country. Some of these returns are embodied in Table LXI. They refer, however, to the wool textile industry as a whole, including carpet and rug manufacture, and in their regional particulars do not distinguish between its several sections. According to this table, the West Riding, was before the war, responsible for approximately four-fifths of the gross output and for three-quarters of the total employment, though its proportion declined between 1924 and 1935. The minor areas are arranged in the following order: the Midlands, Lancashire, southern Scotland, the lower Clyde Valley, the rest of Scotland, the West of England, and, following far behind, Cumberland–Westmorland and Wales. The most striking features of this distribution are, first, the wide scatter of the industry in accord with the wide scatter of the physical conditions favourable to it, as discussed above; but, second, the almost complete absence even of minor centres in the English Plain which has only raw wool among the physical conditions to favour it. There are few mills south-east of the Jurassic escarpment and scarcely any south-east of the chalk escarpment. The third striking feature is that, apart from scattered mills, only the West Riding, Lancashire, and the lower Clyde Valley, coincide with coalfields, and of these Lancashire and the lower Clyde Valley have other major industries which so dominate their regional industrial structure as to leave little place for woollen and worsted manufacture. The predominance of West Yorkshire over Lancashire

TABLE LXI

Regional Distribution of the Wool Textile Industry

(Census of Production returns)

	Percentage of Gross output 1924	Percentage of Gross output 1935	Percentage of Numbers employed 1924	Percentage of Numbers employed 1935	Numbers employed per establishment 1935	Net output as per cent of gross output 1924	Net output as per cent of gross output 1935	Cost of materials, etc., as per cent of gross output 1935
West Riding	81·5	79·4	76·3	73·4	155	25·4	30·8	63·5
Lancashire–Cheshire	3·2	3·8	4·1	4·7	134	34·7	43·5	50·8
West of England		1·9		2·8	159		47·1	47·2
Midlands		5·6		6·8	310		41·3	53·0
Cumberland–Westmorland	7·9	0·3	9·5	0·4	93	34·5	46·0	48·3
Wales		0·2		0·4	84		37·2	57·1
Rest of England		1·0		1·0	124		29·2	65·1
Lower Clyde Valley	2·0	2·6	2·5	3·2	291	43·9	51·5	42·8
Southern Scotland	5·4	2·9	7·6	4·4	157	35·6	44·2	50·1
Rest of Scotland		2·3		2·9	154		48·9	45·4
Great Britain	100·0	100·0	100 0	100 0	160	27·4	33·5	60·8

Cost of materials, fuel, and electricity as a percentage of gross output is calculated on the assumption that work put out is in the same proportion to gross output in each district, but this may well not be the case.

The lower Clyde Valley is described in the Census of Production as the West Central District, and it is virtually the same area (except for the inclusion of Argyll and Bute in 1935 and for the exclusion of northern Ayrshire in 1924 and 1930) as the South-west of Scotland, the area surveyed for the Board of Trade in 1931–2.

and the lower Clyde Valley has been due to the circumstance that the industry was firmly rooted in the West Riding, and, moreover, was expanding rapidly at the very time when (during the Industrial Revolution) the geographical distribution and the economic structure of the industry were both being transformed. The significance of this historical factor, shaped by the economic and social and ultimately by the physical environment of the West Riding, has been discussed above in Chapter II.

The data referring to machine equipment collected for 1918 and 1943 permit the regional analysis to be carried further, for they give regional particulars of each section of the composite wool textile industry. They are set out in Table LXII. I propose to examine here only the general regional figures, leaving aside for the moment the district figures within the West Riding. The combs and worsted spindles refer to the worsted industry, the rag-pulling machines to the shoddy, the carding engines and woollen spindles to the woollen, but the looms refer to both woollen and worsted together, presumably because the same equipment may be used, especially by commission weavers, for both kinds of cloth. It is clear that the West Riding has an even larger share of worsted combing and spinning than it has of the wool textile industry in its total sense. The percentages of combs and of worsted spindles do not exactly correspond and it would appear that, while Scotland does most of its own combing, Lancashire obtained almost all its combed tops and the Midlands some of their tops from the West Riding. The West of England, with scarcely any worsted industry does more combing than worsted spinning and, in fact, one Bradford firm has a combing plant in Devon at the point of origin of the raw material. The West Riding has an equally large share of shoddy manufacture in so far as this is registered by the distribution of rag-pulling machines.[1] Woollen carding and spinning, as shown by the carding engines and woollen spindles, is much more widely dispersed. The West Riding has two-thirds of the machine equipment in woollen carding and spinning as compared with nine-tenths of the machine equipment in worsted combing and spinning. The regional proportions of carding engines[2] and of woollen spindles follow each other closely, as is indeed to be expected by reason of the vertical organization of that trade. Every minor region, except the Midlands, has a relatively greater share of woollen than of worsted spindles, and this was true absolutely as well as relatively. The proportion of looms in the West Riding in both years was a little less than its proportion of woollen and worsted spindles combined,

[1] In 1904 there were 1,008 rag-grinding machines returned by the Factory Inspectors, of which 566 were attributed to shoddy factories, 328 to woollen mills, 101 to felt and flock manufacturers, and 13 to worsted mills.

[2] In 1904 the Factory Inspectors returned 6,725 carding sets, of which 5,883 were attributed to woollen mills, 319 to shoddy factories, 298 to worsted mills, and 225 to felt and flock manufacturers.

but it is to be expected, from its larger share of worsted than of woollen spinning, that it would have a larger proportion of the looms engaged on worsted than on woollen fabrics. It is probable that Scotland, Wales, and the West of England were in 1918 relatively self-contained spinning out the quantity of yarn their looms required. Lancashire, however, had a much greater share of looms than of spindles; it may be inferred that yarns as well as combed tops were brought in from the West Riding. The Midlands, in contrast, have a very small share of looms, and it is clear that the Midland industry is chiefly concerned with yarn spinning. This Midland yarn spinning, in fact, is chiefly for hosiery manufacture. The 1943 and the 1918 returns largely confirm each other in this analysis of regional industrial structure.

For the more detailed analysis of the location of the wool textile industries within each of these regions of the country, it is necessary to use the evidence of the Industry Tables of the Population Census and the evidence of *Worrall's Directories*.[1] Some of the material from *Worrall's Directories* is embodied in Figs. 58 and 59. With the aid of these maps and of the tables, it is possible to consider with some degree of precision the varying location and characteristics of the industry.

The West of England industry is to a large extent a survival in respect of location, though not necessarily in economic organization. As in the period prior to the Industrial Revolution, its individual members are widely scattered in small clusters or as single units over an extended terrain identical with that of the eighteenth century. With scarcely an exception, these mills have a valley site and are located within or on the edges of upland country; that is, they occupy sites which could provide not only water for process work, but also water-power for working the fulling stocks in the domestic phase and, in addition, spinning frames in the early phases of the Industrial Revolution. They have no local coal resources, but when converted to a steam drive, the Stroud mills drew in their coal from the Forest

[1] The 1931 Industry Tables give a detailed industrial classification within the wool textile industry for counties, county boroughs, and other local government areas with a population of over 20,000, but for local government areas with a smaller population there is only a single figure for all wool textile industries together. *Worrall's Directories* give numbers of spindles and of looms for many firms, but not for all, and the machine equipment particulars are much less complete for the woollen and worsted industries than they are for the cotton industry; moreover, the entries do not distinguish looms on woollen and worsted fabrics from looms on fabrics of other materials if these happen to be woven on the same premises. The entry in the *Directory*, however, does permit the mill to be placed on its exact site, whereas the Industry Tables giving particulars for areas and not for sites are much less satisfactory from the mapping point of view. The Industry Tables of 1921 and 1931 differ in that the 1921 tables were constructed according to workplace, but the 1931 according to residence, and they differ in that the areas for which separate returns were made available in 1921 were limited to the larger local government areas. Residence and workplace are not always in the same administrative area.

TABLE LXII

Regional Distribution of Machinery in Woollen and Worsted Industries

A. Percentage of total in Great Britain at end of 1918

	Combs	Worsted spindles	Rag-pulling machines	Carding engines	Woollen spindles	Woollen and worsted Looms	Woollen and worsted Spindles
West Riding	93·4	88·0	91·9	68·7	66·2	76·3	79·6
Lancashire	0·1	3·2	1·4	10·4	9·5	9·8	5·6
West of England	1·3	0·9	0·2	5·6	5·2	2·4	2·6
Midlands	3·0	4·7	4·4	2·2	2·1	0·6	3·7
Wales	—	—	0·5	2·1	1·5	0·9	0·6
Scotland	2·2	3·2	1·6	11·0	15·5	10·0	7·9
Great Britain	100·0	100·0	100·0	100·0	100·0	100·0	100·0
Bradford	72·2	38·6	5·6	2·2	2·4	28·4	24·7
Keighley	7·3	13·1	—	—	—	9·2	8·0
Halifax	7·5	17·8	2·5	6·1	6·3	6·5	13·4
Leeds	1·2	5·1	8·0	8·3	8·8	7·6	6·5
Heavy Woollen	1·0	3·5	48·4	16·6	14·9	7·8	7·9
Huddersfield	3·2	6·6	12·3	27·3	24·9	11·1	13·6
Morley	0·2	1·4	12·5	5·6	6·3	4·2	3·4
Yeadon	0·8	1·9	2·6	2·6	2·6	1·5	2·1

Calculated from tables constructed by G. H. Wood and printed in the annual *Statistics Relating to the Woollen, Worsted, and Artificial Silk Trades* of the Bradford Chamber of Commerce.

B. Percentage of total in Great Britain at end of 1943

	Combs	Worsted spindles	Rag-pulling machines	Carding engines	Woollen spindles	Woollen and worsted Looms	Woollen and worsted Spindles
West Riding, Lancashire	93·8	92·4	96·6	77·9	77·5	85·4	86·3
West of England	1·6	0·5	0·2	5·5	5·8	3·0	2·7
Midlands	2·2	4·9	2·9	2·8	1·9	1·9	3·7
Wales	—	—	—	1·3	0·8	0·5	0·3
Scotland	2·0	2·2	0·3	12·5	14·0	9·0	7·0
Great Britain	100·0	100·0	100·0	100·0	100·0	100·0	100·0

Calculated from Tables 41 and 67 in *Wool*, Working Party Reports (1947). There are some combs and looms in districts other than those specified.

of Dean and employed the Stroudwater Canal for the purpose. With the availability of electricity from the grid these scattered mills, if converted to an electric drive, have now no profound power disadvantages as compared with coalfield sites, except in so far as these may be due to variations in the price charged for electric power. The kinds of cloth manufactured are the traditional specialities of the West Country—billiard cloths, hunting cloths, superfines, military and naval cloths, liveries, flannel cloths, meltons, and beavers,

together with tweeds, serges, and blankets. These are all woollen cloths. The self-contained character of the woollen mill has facilitated the persistence of single units in widely scattered localities and has doubtless facilitated the survival of the West of England industry.

The woollen industry of Wales is very small in dimensions, but it presents some very interesting features. It also is a survival industry scattered over an extended terrain and making cloths traditional to Wales. Many Welsh woollen mills indeed exhibit archaic features of economic organization and of power equipment[1] as well as of location. The sex ratio in Welsh woollen mills is different from that in most other districts, except some of the Scottish. According to the 1931 Industry Tables, the West Riding had two men to three women, the West of England approximately equal numbers of men and women, but Wales had three men to two women and, if factories in Montgomery and Flint, which employ more women than men, be omitted, the rest of Wales had almost three men to one woman. The smaller factories, run by water-power and worked by two or three persons, usually employ local wool, and in 1927 still made up a farmer's own wool into cloth or other material for his own consumption or else made cloth for sale direct to the consumer at a market or a periodic fair. This is an archaic form of economic organization. The larger factories are not dependent on local wool and used imported as well as English wools; they sell their cloth in bulk and their market is not limited to the locality. Of the forty-four premises for which machinery particulars are given in *Worrall's Directory*, distinctions can be drawn between the larger and the smaller. There were eleven which had over ten looms; their average equipment was 1,708 spindles and thirty-nine looms, practically all of these being power looms. There were thirty-three which had under ten looms; their average equipment was 299 spindles and five looms, a considerable proportion of these being hand looms.[2] The Welsh woollen industry has every material requirement at hand—wool,[3] abundant soft water, high humidity, water-power, and, except in mid-Wales, coal. Welsh wool is most satisfactorily employed for flannels and blankets, for rough-surfaced cloths, such as friezes and tweeds, and for stockings. These are the products which the Welsh woollen mills make.[4] The rest of the clip is sent to the Colne Valley

[1] In 1868, when the Welsh woollen industry displayed still more pronounced archaic features, the mills recorded had 736 h.p. of water-power and only 157 h.p. of steam-power, the latter being on or near the South Wales coalfield or in the Severn Valley. In 1904 the Severn Valley had about a third of the machine equipment and the Teifi Valley had under a half.

[2] The ratio of spindles to looms was 60 : 1 in the smaller mills and 44 : 1 in the larger. Some of the smaller mills have more spindles than they need for their looms and sell yarn to hand-loom weavers and stocking knitters.

[3] A. N. Shimmin, 'The Production and Marketing of Wool in Wales', *Welsh Journal of Agriculture*, vol. IV (1928).

[4] H. M. Williams, 'Types of Wool used in Woollen Factories in Wales', *Welsh Journal of Agriculture*, vol. VII (1931).

in the West Riding and to Scotland for tweed-making, to Lancashire and Yorkshire for blanket-making, and it was before the war exported abroad to Germany for blankets and tweeds and to the United States for carpets.[1]

The Midlands have a number of scattered woollen and worsted mills. The following centres are involved: (*a*) Leicester, with subsidiary centres at Nuneaton and Melton Mowbray; (*b*) Coventry; (*c*) Kidderminster. The Midlands are not well endowed by nature for a woollen or worsted industry except in respect of supplies of raw wool and of coal; water tends to be relatively hard, except reservoir water drawn from the Pennines or from Wales, and they are marginal in respect of relative humidity. It will be recalled that the Midlands were involved historically to only a limited extent in wool textile manufacture. The Midland industries are unlike the woollen industries of Wales and of the West of England in that they are not wool textile industries in their own right surviving from a historic past, but are chiefly concerned with yarn spinning preparatory to other manufacturing trades, hosiery and carpets. In Lancashire, apart from worsted yarn spinning alongside cotton yarn spinning at Bolton and Stockport, flannels are made at Rochdale and Littleborough (with neighbouring villages) and in the Saddleworth–Mossley Valley, machinery cloths are made at Bury and felt in Rossendale. The wool textile industry was once much more extensive in Lancashire, and it has been crowded out by the cotton manufacture, though even in the eighteenth century it had been retreating before fustian.

The Scottish woollen industry north and west of the Highland Line exhibits some analogies with the Welsh woollen industry. The mills in the glens are small with an average machinery equipment of no more than 318 spindles and 4½ looms apiece. They make plaidings and traditional homespuns, just as the tiny Welsh mills make traditional Welsh friezes. But there the analogy ends, for the Scottish mills have a more secure market and are not dependent as entirely on the local population for the sale of their fabrics.[2] This outside market for Scottish plaidings and tweeds did not develop until the nineteenth century, and development was then due partly to the Waverley novels and partly to the spread of the Blackface and Cheviot sheep into the Highlands. The manufacture of plaidings is not confined to these tiny Highland mills, for they are made also in Inverness and Aberdeen (whose mills, though larger, are still small) and as a subsidiary line by a few mills in the Tweed Valley, whose main output is of tweeds. The chief woollen manufacturing district of Scotland is situate in the Tweed Valley. Its predominance was

[1] Shimmin, op. cit., p. 74.

[2] In the late eighteenth century, as in Wales at a later period, there had been customer weavers who made up a farmer's own wool for his own use (D. Bremner, *The Industries of Scotland* (1869), p. 154).

once more marked than it is to-day. Although there had long been a small-scale domestic woollen manufacture in the Tweed Valley making relatively coarse fabrics like plaidings, blankets, and 'Galashiels greys' from local wool, the development of the district as a specifically industrial area did not come until the very end of the eighteenth century. Tweels, which by an error was spelt tweeds, then became and have since remained its distinctive product. They soon came to be made of imported as well as of local wool, though the local Cheviot clip is used almost entirely for tweeds and probably contributes to the distinctive qualities of Scottish tweeds. Tweeds are woollens woven from yarns dyed in different colours and milled or fulled to only a limited extent: in both these respects they are different from many other woollen cloths, frequently dyed in the piece and elaborately milled. In addition to tweeds, the district manufactures suitings, coatings and dress goods, and a number of mills spin hosiery yarns. Stocking-making, in fact, preceded tweed manufacture, and for long some mills ran both hosiery and tweed departments. The Tweed Valley has eminently suitable water and humidity, and it has Cheviot wool close at hand. In the initial stages of development the mills employed local water-power, the factory returns of 1868 giving for the Tweed Valley 263 h.p. water-power and 117 h.p. steam-power.[1] Scotland north of the Highland Line also long retained its water-power. In 1868 it was only the industries in the Central Valley of Scotland which had a greater h.p. driven by steam than by falling water. Its initial advantages were thus substantial. Coal for steam generation in the Tweed Valley, however, has to be brought in from outside—from the Central Valley or from the North-east Coast. The economic structure of the Tweed Valley industry is rather different from that of its fellows. The integration of spinning and weaving on the same premises is much less developed in the Tweed Valley than in the woollen industry generally.[2] Of a sample of twenty-nine establishments, eight practise both spinning and weaving, six are spinners only, and fifteen weavers only; of the total equipment less than half of the spindles and looms are in integrated plants. The combined mills had an average of 4,844 spindles and 57 looms apiece, the spinning-mills of 9,297 spindles and the weaving sheds of 40 looms. It may be that the departure from normal practice in the woollen industry is connected with the character of the tweeds woven from dyed yarns of considerable variety, and with the supply of yarn to hosiery and 'making-up' industries. There is an outlier of the tweed district in Dumfries which

[1] Bremner, writing in 1869, however, gives the impression that conversion to steam-power in the Tweed Valley was then general.

[2] This disintegration was gradually developing during the latter part of the nineteenth century. In 1869 four-fifths of the spindles and over nine-tenths of the looms were in premises practising both spinning and weaving. These were the returns of the Factory Inspectors.

is not dissimilarly situated in respect of the qualities of the physical environment. In the West of Scotland the carpet industry is more important than the woollen, and it is the carpet and rug trade that is responsible for the bulk of employment registered by the Census of Production returns of Table LXI. The 1931 Industry Tables give for the counties of Lanark, Renfrew, and Ayr 1,947 in the woollen industry and 6,752 in the carpet industry. There are scattered worsted and hosiery spinners, weavers of tweeds, and makers of Scotch bonnets elsewhere in the Central Lowlands of Scotland. But wool textile manufacture, like cotton, is here subordinate to the metal industries and, among the textiles, to linen, the traditional textile industry of Scotland.

Although the wool textile industry is thus widely diffused over the north and west of Great Britain in harmony with its antiquity and with the wide diffusion (away from the English Plain) of the particular qualities required of the environment, by far the greater part of the industry is focused in West Yorkshire with approximately three-quarters of machine equipment and of numbers employed. This is not as large a concentration as that of the cotton industry into Lancashire–Cheshire, but the cotton never had as wide a diffusion as the working of wool, and could the more readily, as a new industry created by the Industrial Revolution, be focused so largely into a single area. The stages by which the concentration of the woollen and worsted industries into West Yorkshire was accomplished and the causes which operated to effect the concentration at the time have been discussed above in Chapter II. There is no need to recapitulate the social and economic characteristics of West Yorkshire at this period. They distinguished this area from among others with somewhat comparable qualities of water and humidity, and made it pre-eminent. The area happened to be a coalfield as well, but this circumstance, of great importance as it ultimately became, confirmed rather than created its supremacy.

The textile district of West Yorkshire presents certain physical characteristics which have affected the site of mills and which are, therefore, germane to the present analysis. It is slab-like plateau country tilted eastwards with a pronounced scarp and vale surface, diversified by deeply trenched valleys cut down in successive cycles of erosion. The Aire Valley was filled with ice, and it has a broad valley floor, but the Calder Valley had no native glacier and was modelled by melt waters rather than by ice, having thus a narrow deeply cleft floor scarcely wide enough in its upper parts to take the river, railway, road, and canal. The effect of river trenching on the slab-like structure of alternating grits and shales is to give rise to innumerable hillside shelves intermediate in elevation between the entrenched valley floor and the exposed moorland summits. These hillside shelves were the main scene of settlement during the domestic

phase of the woollen and worsted industries prior to the Industrial Revolution: they provided relatively smooth land for farming and their innumerable springs and rivulets provided the water for industrial process work. The valley floors had fulling-mills during the domestic phase, and when water-power replaced hand-power the new mills were mainly set up also in the valley bottoms, but, as space for house-building on the valley floors was restricted, some of the mill-workers continued to live up in the hillside hamlets and a few mills were built on the old sites of domestic industry.[1] Although valley incisions are less deep east of the Lower Coal Measures escarpment, they are yet sufficiently pronounced to expose seams to outcrop workings at a large number of points. Such wide availability of coal facilitated a wide dispersal of mills within the Coal Measure tract: it included both valley floor mills, originally located by water-power, and hillside and hilltop mills which were new creations, never having been driven by water-power. The Millstone Grit tract, however, has little coal and the wide diffusion of steam-driven mills over the hillside, facilitated by the frequent coal outcrops in the Coal Measure tract, was discouraged by the need of coal haulage up steep gradients from the railways along the valley bottoms. Apart from the towns, the riverine distribution of mills is thus more pronounced west of the Lower Coal Measures escarpment than east of it.[2] The largest centres of manufacture, however, are placed at the contact of the two tracts: Halifax lies at the foot of the escarpment, Huddersfield and Bradford lie farther east, but close to the escarpment edge. As a wool textile manufacturing centre, Leeds is now of less importance than these. The industrial area is limited to the Millstone Grit and Coal Measures. Though once thinly scattered over the dales carved out of the Mountain Limestone, the wool textile industry is now almost completely absent from them: the absence must be attributed to the character of the water with its relatively high degree of hardness and its intermittent surface flow and, perhaps, to the comparatively lengthy coal haulage. Although the industry was not absent from the limestone dales during the domestic phase, the thin scatter itself implied that these dales did not present as favourable conditions as the country farther south.

The wool textile industry of West Yorkshire is not one but several. There is the worsted, which includes the use of mohair and other fibres of the goat and camel class; there is the woollen; there are the shoddy and mungo, which, strictly speaking, are preparatory to low woollen manufacture; and there is the carpet industry. These differ

[1] For specific examples in the Huddersfield district, see W. B. Crump and G Ghorbal, *History of the Huddersfield Woollen Industry* (1935).

[2] K. G. T. Clark draws the same contrast in a chapter on the geographical background in J. H. Richardson, *Industrial Employment and Unemployment in Yorkshire* (1936).

from each other in many respects and it is essential to consider them individually and separately.

TABLE LXIII

Extent of Concentration of the Woollen and Worsted Industries into the West Riding

(As percentage of the total number of machines in Great Britain)

	1875	1885	1890	1904	1918
Wool combing	—	—	—	93·4	93·4
Worsted spinning*	90·8	91·6	90·4	91·4	88·0
Worsted weaving	80·5	88·1	91·1	92·8	—
Woollen carding	—	—	—	61·6	68·7
Woollen spinning*	60·2	56·6	58·3	57·2	66·2
Woollen weaving	54·0	60·6	60·1	61·0	—
Total spinning*	72·7	71·5	72·5	75·5	79·6
Total weaving	69·6	76·6	76·3	77·5	76·5

Data of machinery, 1875–1904, have been calculated from the returns of the Factory Inspectors. The 1918 data are from Table LXII. The particulars refer to the whole of Yorkshire for the years 1875–90, but to the West Riding alone for the years 1904 and 1918.

* Excluding doubling spindles.

It will clarify discussion of the distribution and characteristics of each industry if at the outset the technical differences between woollen and worsted be indicated. The worsted fabric is tightly woven of tightly twisted yarns and the pattern of the weave is at once discernible. The woollen fabric is more loosely woven of less tightly twisted yarns and the pattern of the weave is wholly obscured in the heavily milled samples. The strength of the worsted fabric is due to the strength of the yarn and to the closeness of the weave: the strength of the woollen fabric is due to the felting of the individual fibres into a close and smooth surface mat by means of fulling or milling subsequent to weaving. Not all woollens are so heavily milled, tweeds being an example. The difference in the finished fabric does not originate in the weaving shed. The woollen and worsted industries are separate from the very beginning. Originally, worsted yarns were spun only from long wools and woollen yarns chiefly from short wools, but to-day this difference is blurred, though it is by no means absent. After scouring and carbonizing to remove impurities, wool for worsted manufacture is combed, but for woollen manufacture carded.[1] The object of combing is to arrange the fibres parallel to each other and to remove the short wools. The parallelized fibres or tops are used in worsted spinning and the short wools or noils rejected by the combs are employed, along with other wools which have never been combed, by the woollen spinners. The object

[1] The shorter of the worsted wools are also carded by worsted cards prior to combing.

of woollen carding is quite different. It is to mix the fibres thoroughly to break down 'the staple form of the wool', and to produce an even film from which woollen yarn is subsequently spun. The spinning, that is, the drawing out and the twisting of the parallelized fibres or of the film of wool which follows combing or carding respectively, is more elaborate and involves more processes in the worsted than in the woollen spinning room for woollen yarns are usually thicker and less tightly twisted.[1] Woollen yarns are spun chiefly on mules: at the close of 1943 of the total woollen spindles in Great Britain, 96·8 per cent and in the West Riding and Lancashire 97·6 per cent were mules. The mule produces an elastic yarn suitable for woollen fabrics and for hosiery. In worsted spinning the mule is employed to only a limited extent: at the close of 1943 of the total worsted spindles in Great Britain only 13·2 per cent and in the West Riding only 13·1 per cent were mules.[2] The greater number of worsted spindles are cap and fly which spin the strong, well-twisted yarns which the worsted industry requires.[3] The two industries are thus carried on independently of one another. A number of firms are yarn spinners, spinning both woollen and worsted yarns, but some at any rate of these are spinners of carpet and hosiery yarns; a number of weaving sheds, particularly those which work on commission, weave both woollen and worsted fabrics; but only a minority of mills are thus linked up with both industries, and these only under special circumstances.

The worsted was not the initial wool textile industry of West Yorkshire. Broadcloths and kerseys, both woollens, had been made since the fifteenth century, and worsted manufacture on any appreciable scale dates back only to the late seventeenth century. But, despite lateness of development, the Yorkshire worsted industry is concentrated into West Yorkshire to a greater extent than the woollen industry, and to an extent equal to the concentration of the cotton industry into Lancashire–Cheshire. The West Yorkshire worsted industry is organized horizontally. The extent to which this is true is indicated by Table LXIV, which has been calculated from the sample of firms for which particulars of machinery are given in

[1] The comparative sequence of operations is set out by W. E. Morton, *An Introduction to the Study of Spinning* (1937).

[2] Mules are used in the French system of worsted spinning and in the spinning of some fine botany yarns.

[3] For the principles on which these different spinning systems work, see Morton, op. cit.

Maps drawn from data in *Worrall's Directory* Each dot is placed on the site of one worsted spinning mill (A) and of one worsted weaving shed (B). Those worsted firms which both spin and weave on the same site are omitted from these two maps· these are shown on Fig. 59A. Several firms sharing the same premises are marked by a single dot. It is not possible, as it is for Lancashire cotton mills (see Fig. 62), to indicate size, for *Worrall's Directory* gives particulars of spindleage and loomage for only a sample of firms. The distribution is that of the 'twenties, but there have been comparatively few changes since that time

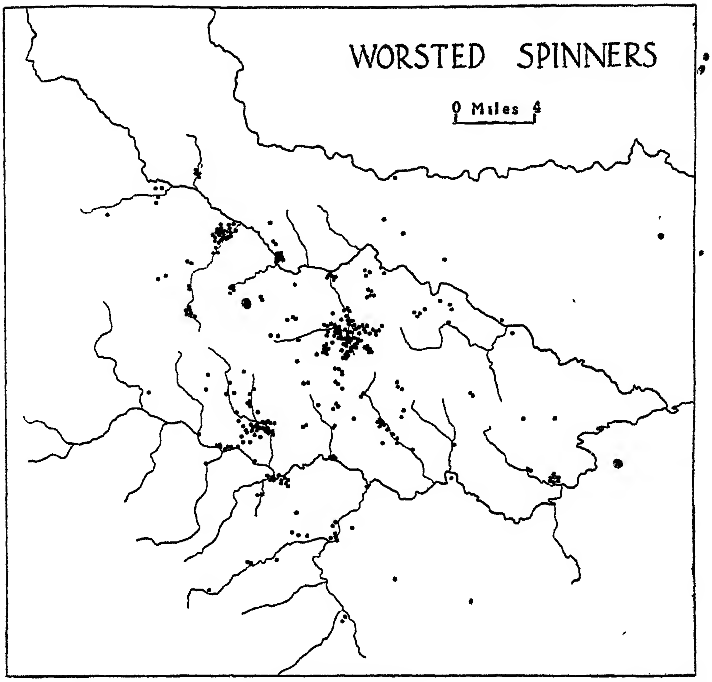

Fig. 58A

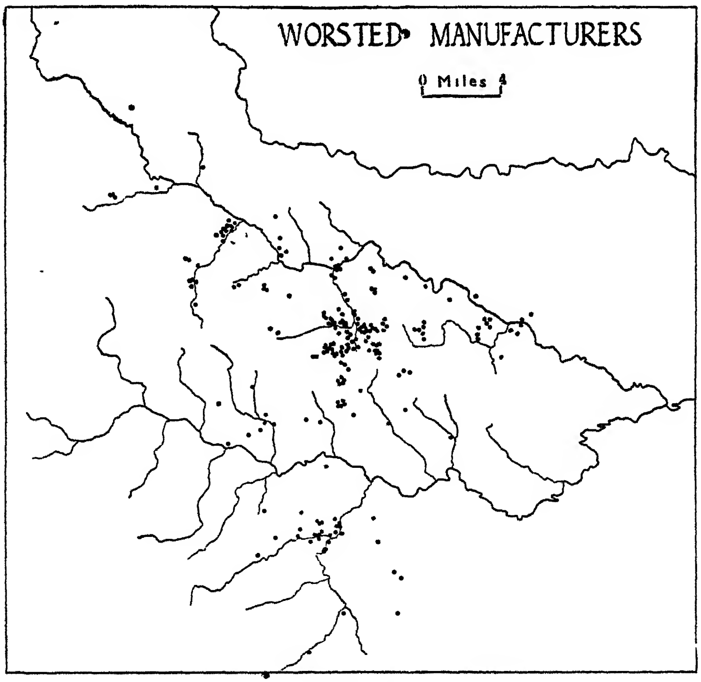

Fig. 58B

SPECIALIST WORSTED SPINNERS AND SPECIALIST WORSTED MANUFACTURERS IN WEST YORKSHIRE

TABLE LXIV

Extent of Horizontal Organization in the West Yorkshire Woollen and Worsted Industries, 1937–8

(Percentage of spindles and of looms in each industry)

A sample

	Worsted		Woollen	
	Spindles	Looms	Spindles	Looms
In firms with both spinning and weaving	28·2	28·6	89·5	91·8
In firms spinning only	71·8	—	10·5	—
In firms weaving only	—	71·4	—	8·2
All firms in sample	100·0	100·0	100·0	100·0

Worrall's Directory for 1937–8. Referring to a sample only and not to all firms, it can be used only to give an order of magnitude and not exact proportions. It is clear that little more than a quarter of all spindles and looms in the worsted industry belong to firms which practise both spinning and weaving. Even these, however, are not fully integrated concerns, for few do their own combing and few their own dyeing and finishing. The late G. H. Wood observed that 'even such vertical organization as apparently exists in large complex concerns is often more apparent than real'.[1] Few, if any, of these apparently integrated concerns have completely balanced spinning and weaving departments; they may produce more yarn than they can weave or insufficient yarn to occupy their looms and they sell or buy yarn like the specialist concerns. The West Yorkshire worsted industry, therefore, is organized primarily on horizontal lines. The particulars of average size, measured by number of spindles and/or looms, are set out in Table LXV(A) for the same sample as Table LXIV, and it will be noticed that the integrated premises and firms were in 1937–8 substantially larger in size than worsted spinners and worsted manufacturers separately. This was also true at earlier dates, as Table LXV(B) shows. This is largely because some of the integrated concerns are of huge dimensions; if the six largest firms be omitted from the integrated plants the average number of spindles per mill in 1937–8 would become 12,252 and of looms 187, the spinning and weaving departments individually being thus more comparable with the equipment of specialist

[1] G. H. Wood, 'An Examination of Some Statistics Relating to the Wool Textile Industry', *Journal Royal Statistical Society*, vol. xc (1927), p. 298.

Maps drawn from data in *Worrall's Directory*. Each dot is placed on the site of one mill, practising both spinning and weaving on the same site. See notes under Fig. 58.

spinning-mills and weaving sheds. The average firm is smaller than the average mill in specialist worsted weaving as some mills are shared by several firms.

TABLE LXV

Average Size of Mills and Firms in West Yorkshire Woollen and Worsted Industries

A. 1937–8

A sample

	Average mill		Average firm	
	Spindles	Looms	Spindles	Looms
Worsted spinners and manufacturers	18,575	261	20,041	281
Worsted spinners	15,599	—	16,497	—
Worsted manufacturers	—	163	—	136
Woollen spinners and manufacturers	5,967	114	7,189	137
Woollen spinners	5,693	—	5,693	—
Woollen manufacturers	—	72	—	75

B. 1875 and 1904

	Average factory			
	1875		1904	
	Spindles	Looms	Spindles	Looms
Worsted spinners and manufacturers	7,910	291	10,254	188
Worsted spinners	4,748	—	7,265	—
Worsted manufacturers	—	162	—	111
Woollen spinners and manufacturers	2,639	53	3,306	67
Woollen spinners	2,246	—	2,727	—
Woollen manufacturers	—	37	—	31

For the whole country the returns of the Worsted Spinners' Federation for 1945 show an average number of spindles of 10,391 for worsted spinners and of 13,981 for worsted spinners and manufacturers

The causes of this horizontal organization are to be found in part in the conditions at the time of the growth of the industry in the eighteenth and early nineteenth centuries, just as the conditions in the cotton industry at the time of its rapid expansion in the mid-nineteenth century are largely responsible for the territorial segregation of spinning-mills and weaving sheds into different quarters of eastern Lancashire. The worsted manufacture of East Anglia had been organized sectionally, North-east Norfolk being the focus of worsted weaving and finishing and worsted spinning being widespread not only in the villages of East Anglia, but as far afield as Yorkshire and Westmorland. Even at a later date some Yorkshire

mill-spun yarn went into East Anglia.[1] When West Yorkshire itself during the domestic phase of the industry, developed a worsted manufacture it could not spin sufficient yarn for the purpose, and spinning was put out over a wide area. Craven, North Lancashire, Cheshire, and North Derbyshire were drawn on for this purpose. The separation of spinning and weaving was true also of the early phases of the factory system, for power was first applied to spinning[2] and worsted fabrics continued to be woven on hand-looms. Thus rooted in historical circumstances, the separation has persisted. Even prior to the Industrial Revolution the Yorkshire worsted industry was in the hands of large capitalists and the manufacturing units in the latter part of the nineteenth century, and at the present day, as Table LXV shows, tend to be of larger dimensions than in the woollen industry. Added to this historical inheritance, there is a technical cause for the separation of worsted spinning and worsted weaving in the existence of a substantial trade in yarn. The worsted industry of the Midlands is concerned with the spinning of hosiery and knitting yarns, and there are many worsted spinners in West Yorkshire which are similarly concerned primarily with hosiery and knitting yarns. The development of an export trade in worsted yarn exercised a similar effect. The existence of an external yarn market in the West Yorkshire worsted trade, therefore, has encouraged the physical separation of spinning from weaving into separate establishments. It may be observed parenthetically that combing has been separated from worsted spinning very largely for similar reasons: there is an export trade in combed tops, both abroad and to other worsted-spinning districts elsewhere in Great Britain, and, moreover, combing serves the woollen as well as the worsted industries, supplying the former with noils and the latter with tops. Some worsted spinning-mills do their own combing, but it is uncommon. A further technical factor has favoured worsted weaving sheds independent of worsted spinning-mills: this is of the variety of materials, including silk and artificial silk and sometimes cotton as well as wool, employed by the weaver of worsted stuffs. Only a giant concern could produce all these materials on the same premises and so approach self-sufficiency.

The district within West Yorkshire where the worsted industry is localized is well defined. It is primarily the north-western and not the south-eastern half. Of the 1937–8 sample of worsted-mills in West Yorkshire employed for Tables LXIV and LXV, 66·5 per cent of the spindles and 83·9 per cent of the looms lay in that part of Airedale, with its lateral tributary valleys, lying upstream from, but including, Bradford. The same area had only 1·5 per cent

[1] J. H. Clapham, *Woollen and Worsted Industries* (1907), pp. 141–2.

[2] It is very significant that the earliest worsted-spinning mills driven by water-power were in Wyresdale and Wharfedale; that is, in what were then the hand-spinning districts.

of the spindles and 1·2 per cent of the looms of the woollen-mills in the sample. The worsted area, however, is rather more extensive than this. It includes Halifax, which has scarcely any woollen manufacture, and it includes the villages east of both Bradford and Halifax up to the line marked by Stanningley, Pudsey, and Cleckheaton. The main worsted area practised worsted manufacture during the eighteenth century, but it was then less extensive, for its eastern boundary then ran from Baildon through Bradford, Wibsey, and Wyke, to Brighouse.[1] The worsted manufacture expanded eastwards during the course of the nineteenth century into formerly woollen territory at a time when the market for worsted cloth was expanding. This striking concentration of the Yorkshire worsted industry is paralleled by the equally striking territorial segregation of cotton-spinning mills and of cotton-weaving sheds into particular parts of Lancashire. It was in harmony with the technical specialization of nineteenth-century industrialism that like should thus be closely associated physically with like, and it is in harmony with the external economies factor of the economist. It was perhaps more essential in a sectionalized industry like worsted than in a much less sectionalized industry like woollen, for its spinners were dependent on specialist combers for their tops and its weavers on specialist spinners for their yarns. But, although combing, spinning, and weaving are performed by separate firms and establishments, they are not territorially segregated into separate districts of the worsted area, unlike cotton spinning and weaving in Lancashire focused into separate districts, the one south and the other north of Rossendale. It may be asserted that territorial segregation of spinning and weaving each into separate districts in a horizontally organized industry is not necessarily a concomitant of that horizontal organization. It arose in the Lancashire cotton industry owing to historical circumstance, and owing to the great size and bulk it developed during the course of the nineteenth century. The West Yorkshire worsted industry exhibits the more normal arrangement of spinners and weavers, though separate concerns, in the same towns.[2] The only approach to a worsted manufacturing district with comparatively little spinning is in Airedale, above Keighley. This was incorporated into the worsted industry for somewhat similar reasons to the incorporation of the cotton-weaving district, and particularly its north-eastern part, into Lancashire cotton industry. The two districts are contiguous, they merge in respect of the type of fabric woven, worsted sheds weaving womens' dress goods often temporarily turning over to cotton, and they are somewhat comparable in scale of operation and in the practice of the room and power

[1] Map in Heaton, *The Yorkshire Woollen and Worsted Industries* (1920), p. 287.

[2] It does not necessarily follow, of course, that a worsted manufacturer in, say, Bradford gets his yarn from a Bradford worsted spinner.

system.[1] The only approach to a worsted-spinning district with comparatively little worsted manufacturing, though it is not as clear a case in specialization as the foregoing, is in the Halifax district including Greetland, Elland, and Sowerby Bridge.

Within this worsted district an interesting contrast may be drawn between town and country. The towns, of course, are the main seat

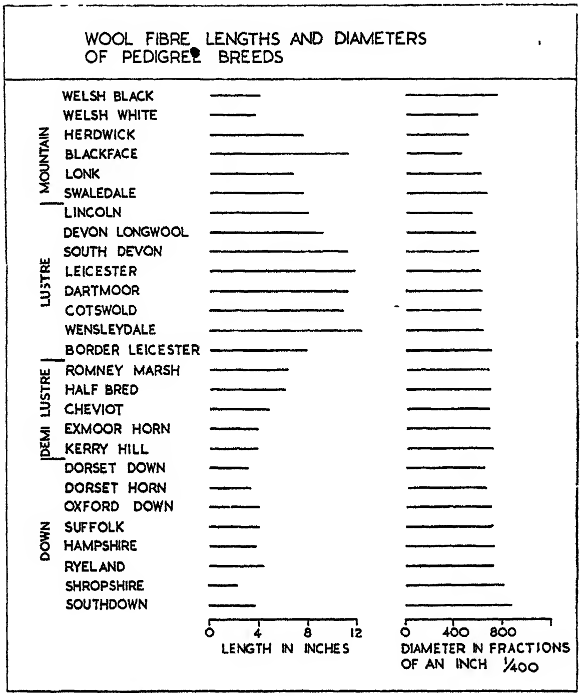

Fig. 60

LENGTH AND DIAMETER OF THE WOOL FIBRE OF PEDIGREE BREEDS OF BRITISH SHEEP

The length is shown to the left, the length of the line increasing with the length of the fibre. The diameter is shown to the right, the length of the line increasing with the fineness of the fibre: thus the Shropshire has a diameter of approximately 1/800 of an inch, the Blackface of approximately 1/500 of an inch. Diagram drawn from a table in *Journal Royal Agricultural Society* (1924) by A. F. Barker.

of manufacture and they have a large share of the spindleage and loomage. But, in proportion to their total equipment, the country districts have a relatively large share of the integrated worsted spinners and manufacturers while the towns have a relatively large share of the specialist worsted spinners and of the specialist worsted

[1] A single mill or shed is let out to several manufacturing firms, each occupying a floor or part of a floor, but drawing their power from a common power-house.

weavers. While in Bradford 23·8 per cent of the worsted spindles and 19·5 per cent of the worsted looms of the 1937–8 sample were in integrated firms, in the villages within the Bradford district the percentages were 50·5 and 47·5 respectively. In the villages the integrated plants thus tend to be relatively more numerous than in the towns, perhaps because of relative remoteness. In many cases a single concern dominates the entire industrial life of the village. Examples are Queensbury and Denholme. Other village mills tend to be smaller in size than the town mills.[1] It is clear that the specialist concerns are not only more numerous, but also more highly developed in the towns. There is a somewhat similar differentiation between town and country in the Lancashire cotton industry.

While the worsted industry of West Yorkshire has a horizontal organization, the woollen has a vertical organization. The extent of the vertical organization is indicated in Table LXIV. In fact, according to this sample, a vertical organization is even more clearly the rule in the woollen than is a horizontal organization in the worsted. It will be noticed from the particulars of size given in Table LXV that if integrated establishments, specialist spinning-mills and specialist weaving sheds be compared in each industry, the woollen-mills are in each case smaller in size than the worsted-mills, in so far as this can be tested by numbers of spindles and looms.[2] The larger and more complete sample of woollen- and worsted-mills of the Factory Inspectors' returns for 1875 and 1904 show precisely the same differences. What are the reasons for these differences in organization and in size between woollen and worsted industries?

The vertical organization of the woollen represents in part an inheritance from the domestic system prior to the Industrial Revolution, and in the West Riding woollen industry the small master clothier predominated to a much greater extent than in the West Country industry, organized on a more capitalist basis. In the eighteenth century it was still possible for family labour alone to produce the two pieces per week which consituted the output of the typical small master clothier, and the only work which need be put out was fulling and, perhaps, finishing. Some of these small master clothiers persisted until the middle of the nineteenth century. The cloth halls of Leeds, where there were two, Halifax, Huddersfield, Wakefield, Bradford, Gomersal, and Colne, with their hundreds of stands or rooms, bore witness to this multiplicity of manufacturers. It is significant that the decay of the Halifax Cloth Hall began about

[1] This does not apply to the weaving sheds in the Airedale villages above Keighley: these are the largest sheds in the worsted area and they approximate more in size to the cotton weaving sheds of East Lancashire. A single shed, however, frequently houses several firms.

[2] This test of equipment over-emphasizes the difference in size for woollen looms are usually broader than worsted looms.

the middle of the nineteenth century.[1] There were capitalist clothiers, however, in the West Yorkshire woollen, as well as in the West Yorkshire worsted and in the West Country woollen industries, and during the eighteenth century they grew in number and in the proportion of the trade they handled. The persistence of the small master clothier and the long-drawn-out transition from the domestic to the factory system permitted many master clothiers to set up small woollen-mills with a few power-driven spinning frames and a few power looms and gradually to increase their scale of operations out of profits. Very many of these woollen-mills are still private companies and are still in essence family businesses.[2] Technical factors have also been partly responsible for the horizontal organization. The success of the woollen manufacturer in the Yorkshire woollen trade has for some decades depended very largely, so it has been declared, on the skill in blending wool, shoddy, and cotton preparatory to spinning.[3] Woollen yarns are bought for weaving only by the specialist weaving sheds, which are relatively few in number and small in size: most woollen yarn spinners, in fact, are concerned with carpet, hosiery, and knitting yarns. There is little export of woollen yarn whether abroad or to other districts within Britain. If the presence of an export trade in worsted yarn has encouraged a horizontal organization in worsted, its absence in respect of woollen yarn has presumably discouraged it in woollen. The small size of the woollen-mill is due partly to its small-scale inheritance, to the persistence of the family business, and perhaps also to the linear stream-side location common among woollen-mills, implying a restricted site.

The woollen district within the West Riding industrial area is equally as well defined as the worsted. While the north-western sector is occupied by the worsted, the south-eastern sector is occupied by the woollen and there are few outliers of worsted within it. There is some worsted in the Huddersfield district and some worsted spinning in the Wakefield district. There was, indeed, worsted manufacture in Wakefield in the eighteenth century.[4] The greater part of the woollen industry lies within the area of the Coal Measures

[1] Heaton, op. cit., p. 380.

[2] 'They are almost invariably private limited liability companies, which have been handed down from father to son for at least two generations, and the third generation is actively engaged in preparing itself for the succession' (G. H. Wood, *Journal Textile Institute* (1938)). The contrast with the Lancashire cotton industry with its public companies is complete. The two or three generations are in many, if not most, instances sufficient to carry the firm back to the beginnings of power-driven factory industry.

[3] J. H. Clapham, 'Industrial Organization in the Woollen and Worsted Industries of Yorkshire', *Economic Journal*, vol. XVI (1906), p. 521.

[4] There are only stray references to worsted manufacture in the Huddersfield district at this date. An inventory of 1779 referring to Honley lists 'a pair of worsted looms' which Crump and Ghorbal describe as the surprise of the inventory (Crump and Ghorbal, op. cit., pp. 66–7).

and the only outliers within the Millstone Grit are along the valley floors of the Calder and of its tributaries, including the Colne and the Holme. There is scarcely any woollen manufacture in Airedale, upstream of Yeadon and Guiseley. The western margins of the woollen district, however, have been invaded by the worsted, which was the first to be mechanized, and which appears to have expanded the more rapidly during the nineteenth century. The expansion of the worsted into the woollen area had been proceeding even during the eighteenth century. Sam Hill of Soyland, a hillside shelf overlooking the Ripponden Valley, itself a tributary of the Calder, began his manufacturing career as a maker of kerseys, the traditional woollens of the district, but ended it as a maker of shalloons, the chief worsted fabric of West Yorkshire in the eighteenth century.[1] Prior to the development of factory industry the woollen was larger than the worsted in West Yorkshire, judging from a 1772 estimate of output by value.[2] But by 1875 the worsted had grown to be substantially the larger, according to a return by the Factory Inspectors, of machine equipment and of numbers employed in factories.[3] The town of Halifax, once wholly dependent on kerseys, now does scarcely any woollen work, though the villages around Halifax and the Calder Valley above Halifax still have many woollen-mills. The expansion of the worsted industry beyond Halifax and across the Lower Coal Measures escarpment as far east as the Stanningley–Cleckheaton line has been indicated above. The settlement of the woollen and worsted industries into separate sectors of the West Yorkshire industrial area is thus in part an inheritance from the distribution pattern of the eighteenth century. The woollen was firmly fixed in its historic habitat and only Airedale was relatively empty of manufacture and thus available for the new industry.

The woollen, much more than the worsted, industry has a riverine location. Occupying solid blocks of territory, they each include large towns, small towns, and villages, but they involve these in different proportions, and within each district mills tend to be located differently. Of the worsted spindles in the 1937–8 sample, 40 per cent were in county boroughs, 9 per cent in municipal boroughs, and 51 per cent in urban and rural districts; of the woollen spindles the proportions were 21, 26, and 53 per cent respectively. The proportions for worsted and woollen looms display similar variations. The

[1] *The Letter Books of Joseph Holroyd and Sam Hill*, ed. by H. Heaton (Bankfield Museum Notes, Halifax (1914)).

[2] Quoted by Bischoff, *Woollen and Worsted*, vol. 1, pp. 186–90. Manufactures from short wool were valued at £1·87 million and from combing wool at £1·40 million.

[3] The number of spindles was 1·89 million in the woollen and 1·98 million in the worsted; of looms, 30,700 in the woollen and 65,800 in the worsted; of persons employed, 68,000 in the woollen and 114,000 in the worsted. Some corrections must be made to these figures before they can be regarded as strictly comparable. It is probable that the mechanization of both industries was virtually complete by this date, although there were still over 100 male weavers working at home on their own account in Yorkshire in 1901.

boroughs are equally prominent in both industries,[1] but it will be noticed that the worsted is much more prominent than the woollen in the large towns and the woollen than the worsted in the small towns. In the large towns there are some worsted-mills with a riverine site, but they are mostly removed from the rivers and are scattered throughout the built-up area. If worsted-mills had been tied down to riverine sites, these large towns could not have grown to their present dimensions dependent on the worsted industry. In the smaller towns the retention of a riverine site for woollen-mills, though far from universal, has not been so difficult. In the country districts a riverine site for woollen-mills is the rule, but there are hilltop or plateau summit woollen- as well as worsted-mills.

The reasons for this general, though by no means absolute, difference in type of site are bound up with the horizontal organization of the worsted and the vertical organization of the woollen. The latter practises all processes on the same site, except dyeing, which has become a chemist's business, and consequently requires water at many successive stages of manufacture. The possession of water rights whereby water may be drawn from a river or stream was essential prior to the provision of piped supplies, and even now is cheaper than the purchase of gravitation water from the town's mains, though as a percentage of the value of the finished article the cost of water is small. The horizontal organization of the worsted, on the other hand, implies that mills following single processes may require no water whatever for process work, and there is nothing to hinder the construction of these away from the rivers and streams. The water requirement is focused on certain premises only of the worsted industry, and these have either a riverine site or, if located in a large town, draw water from the town's mains. A further factor which has encouraged a riverine site for woollen-mills is the frequency with which a woollen-mill grew out of a scribbling or carding-mill driven by water-power. Many of these were company mills owned by groups of small master clothiers.[2] Other woollen-mills grew out of the domestic manufacture and the warehouse of a master clothier; these were not infrequently on the hillside shelves above the valley floors. The two types of site have been mapped for the Huddersfield district, and it is clear that the riverine sites of the one greatly outnumber (by 5 : 1) the non-riverine sites of the other.[3]

The shoddy manufacture occupies particular districts within the

[1] The urban districts are more prominent than in the Lancashire cotton industry, where the boroughs dominate the scene. In 1937 West Yorkshire had six county boroughs, six municipal boroughs, and nearly three-score urban districts, but the Lancashire textile area had eleven county boroughs, seventeen municipal boroughs, and two-score urban districts.

[2] J. H. Clapham, *Woollen and Worsted Industries* (1907), p. 129, and W. B. Crump (ed.), *The Leeds Woollen Industry* (1931).

[3] Crump and Ghorbal, op. cit., p. 117.

south-eastern woollen sector. Shoddy and mungo are made from old rags and waste. Some shoddy and mungo manufacturers make simply the shoddy or mungo sorted and graded ready for carding by woollen spinners and manufacturers who employ rag wool along with new wool; other manufacturers employ their own sortings and work them up into finished cloth. Writing in 1907, Prof. J. H. Clapham stated that 'two-thirds of the shoddy factories contained no carding machinery', though the largest had carding engines.[1] The makers of shoddy are thus not all users of shoddy in cloth manufacture. It is the woollen rather than the worsted trade that employs shoddy, and the differing nature of woollen and worsted fabrics is doubtless responsible. The seat of the shoddy and mungo industry is the heavy woollen district of Dewsbury, Batley, and Ossett; the heavy woollen district and the Colne Valley make 'low woollens'. In addition to these primary centres there are individual shoddy-mills scattered throughout the woollen area. The shoddy-mills are generally smaller than the woollen-mills, just as the cotton-waste mills of Rossendale are smaller than the cotton-mills of South-east and East Lancashire, and the dimensions of shoddy and mungo manufacture are very much smaller than those of the woollen industry proper. There is scarcely any shoddy or mungo manufacture elsewhere than in West Yorkshire, those in the rest of the country attributed to the Census group 'mungo making; rag grinding and carbonizing' being rag grinders and carbonizers.

Carpet-making in West Yorkshire, according to the 1931 Industry Tables, then involved twice as many persons as shoddy and mungo manufacture, but it employed little more than a fifth of the total in carpet-making in Great Britain. The Census group includes rugs along with carpets. In West Yorkshire the industry is centred along the middle stretches of the Calder Valley (together with its tributaries) between Halifax and Dewsbury. It thus significantly overlaps both woollen and worsted districts at the very point where they are adjacent; the overlap is significant, for the industry uses both woollen and worsted yarns as well as other textile materials. In addition, there is some rug-making by the manufacturers of plush and chenille fabrics in the worsted districts of Airedale. But nowhere are carpets the sole manufacture of the place as they are at Kidderminster in Worcestershire.

III

TRENDS IN DISTRIBUTION

Having thus examined the location and character of each manufacturing district in a static sense, let us now turn to the study of location in a dynamic sense and discover the extent of change. In order to put the problem in its proper perspective it is necessary to

[1] Clapham, *Woollen and Worsted Industries*, p. 125.

consider the trends of the late nineteenth century as well as those of the inter-war years.

The first point to investigate is the extent to which there have been major regional changes in the location of the industry. The Factory Inspectors' returns of machine equipment[1] are set out in Table LXVI.

Long before the years to which the Factory Inspectors' returns of Table LXVI refer, worsted spinning had become concentrated in West Yorkshire, and there was virtually little change in the percentage share of Yorkshire throughout the years covered by these returns. The second district, the Midlands, was very much smaller, but was growing steadily after 1885 and had substantially increased its percentage share by 1918; the growth of the Midlands quite clearly reflected the expansion of the hosiery trade for which the worsted spinning of the Midlands is mainly designed. The percentage share of Scotland remained steady, but worsted spinning is a very minor Scottish textile trade. Worsted spinning in Lancashire was insignificant throughout: it is largely of worsted hosiery yarns[2] spun on the same premises as hosiery yarns of other materials.[3] Throughout the period covered by the Inspectors' returns worsted spinning was a growing industry, particularly after 1890. The increasing demand for worsted yarn for hosiery and, as will appear later, for export abroad, was responsible for this growth. The trends in worsted weaving were quite different. The percentage share of West Yorkshire was increasing steadily throughout the period and the percentage shares of Scotland and of Lancashire were as steadily decreasing. Prof. J. H. Clapham advanced the view that in the nineteenth century

[1] The Factory Inspectors made returns printed in 1868, but these do not tie up successfully with succeeding returns, and they have accordingly been omitted from the table. The 1918 and 1943 Censuses were drawn up by hands other than those of the Factory Inspectors and, it would appear probable, with greater accuracy. For these reasons the 1918 and 1943 returns also have been omitted from the table, though some references are made to them in the text. There is some uncertainty as to the precise dates to which the returns embodied in the table refer. They were ordered to be printed and laid before the House of Commons in 1875, 1879, 1885, 1890, and 1904, but the instruction to collect the data frequently dates to the previous year (1874, 1878, 1885, 1889, and 1904 respectively). The comments on the accuracy of the Factory Inspectors' returns made by the Departmental Committee on Factory Statistics in 1895 are that they 'represent to a certain extent the position of British manufactures at the dates named . . . and can in no sense be said to be of more than approximate accuracy; this observation applies more strongly to the returns from the non-textile, than to those from the textile districts; the latter . . . may be taken to be tolerably reliable.' The Factory Inspectors were handicapped by not having statutory powers to make returns compulsory.

[2] The term 'hosiery' is not limited to hose: it includes underwear and outerwear, if made by a knitting as distinct from a weaving process.

[3] It is possible that the Factory Inspectors had returned this worsted spinning which was on the same premises as cotton spinning along with the cotton industry. The 1918 returns display a marked increase in worsted spinning in Lancashire, but these were collected by a special body then in control of the industry, and the personal knowledge of individual mills possessed by its statistical officer was used in classifying the returns into their final form.

worsted weaving developed in woollen districts at a time when worsteds were gaining at the expense of woollens and when West Yorkshire could not itself weave all the worsted yarns it produced.[1] It may be that the larger percentage shares of Scotland and of Lancashire in 1875 were an index of this. But, as the number of worsted looms in the country began to decline, these subordinate districts declined more rapidly than the centre, and worsted weaving came to be concentrated more and more on West Yorkshire. The outposts were withdrawn and the centre and focus of the industry increased its dominance. The growth of worsted spinning was expressed, conversely, in an expansion of the outposts to a greater degree than that of the main centre; these outposts were hosiery districts which were pushing back their activities into the production of their raw material.

The elucidation of regional trends in the woollen industry is made more difficult by the persistence of the domestic handicraft industry even as late as the last quarter of the nineteenth century. The increase, both actual and relative, of the woollen spindles and looms of Wales recorded by the Factory Inspectors may thus be attributed to the conversion from domestic to factory industry, for the returns of the Factory Inspectors excluded spinning-wheels and hand-looms. Woollen spinning changed comparatively little in location from 1875 to 1904. As a percentage of the total spindles in Great Britain, it tended to decline a little in Yorkshire, in Lancashire, and in the West of England, and it tended to increase in Scotland and in Wales, but in Scotland, as well as in Wales, the conversion from domestic to factory industry complicated the position. In the statistics for woollen looms the 1875 returns seem out of line with those of later dates. If these be ignored, then the percentage shares of Yorkshire, Lancashire, and the West of England tended to decline, and of Scotland, Wales, and other districts tended to increase. The regional trends of spindles and of looms are in harmony, as is indeed to be expected in view of the large measure of integration in the woollen industry. The divergence in the regional trends of spindles as compared with looms in the worsted trade, therefore, is all the more striking and is a further witness of the lack of integration in that trade. During this period the woollen industry was declining and Great Britain had in 1904 only 81 per cent of the spinning spindles and 89 per cent of the power looms that it had had in 1875.[2]

The returns of the Factory Inspectors were classified to refer separately to premises practising both spinning and weaving and to premises practising spinning alone or weaving alone. These have been reduced to percentages of total spindles and of total looms in Table LXVII. It is clear that in the worsted the disintegration

[1] Clapham, *Economic Journal*, vol. XVI (1906), p. 518.
[2] Efficiency in terms of output per spindle and per loom was no doubt greater.

TABLE LXVI

Regional Trends in Woollen and Worsted Industries. I

(On the evidence of machine equipment)

WOOLLEN

Spinning Spindles

	Nos. in millions	Index Nos.	Percentages in				
			York-shire	Scot-land	Lanca-shire	West of England	Wales
1875	3·13	100	60·2	16·9	12·3	4·5	1·1
1879	3·30	105	59·7	17·0	11·6	4·3	1·6
1885	2·98	95	56·6	18·5	12·2	4·9	2·8
1890	3·04	97	58·3	18·6	11·3	4·4	2·7
1904	2·55	81	57·2	19·4	10·4	3·9	3·0

Looms

	Nos. in thou-sands	Index Nos	Percentages in				
			York-shire	Scot-land	Lanca-shire	West of England	Wales
1875	56·8	100	54·0	20·7	15·9	4·6	1·0
1879	56·5	100	63·5	11·1	15·5	5·4	0·8
1885	57·2	101	60·6	13·9	14·8	4·8	1·5
1890	60·9	107	60·1	16·1	14·1	4·2	1·5
1904	49·2	89	61·0	14·8	13·0	3·3	2·2

WORSTED

Spinning Spindles

	Nos. in millions	Index Nos.	Percentages in			
			Yorkshire	Scotland	Midlands	Lancashire
1875	2·18	100	90·8	2·4	3·6	1·4
1879	2·10	96	91·9	2·4	3·8	0·3
1885	2·23	102	91·6	2·6	3·4	0·3
1890	2·40	110	90·4	2·5	4·8	1·1
1904	2·94	135	91·4	1·8	4·4	0 7

Looms

	Nos. in thousands	Index Nos.	Percentages in		
			Yorkshire	Scotland	Lancashire
1875	81·7	100	80·5	7·5	8·3
1879	87·4	107	78·6	12·9	5·8
1885	79·9	89	88·1	1·8	6·3
1890	67·4	82	91·1	1·1	4·1
1904	52·7	64	92·8	2·3	0·6

West of England here excludes Gloucestershire, which in the Factory Inspectors' returns for 1875, 1879, 1885, and 1890 is merged with Hereford, Salop, Stafford, Worcester, and Warwick.

was progressive, but was much more marked in respect of spindles than of looms. This is in harmony with the increasing importance of hosiery yarns among worsted spinners, and it helps to prove the point advanced by Prof. J. H. Clapham that an external market for worsted yarn was a cause of the disintegration. In the Midlands and in Scotland, much of whose worsted spinning is for hosiery, the disintegration was much more marked than in Yorkshire even in 1875. In the woollen trade there was no pronounced trend for Great Britain as a whole. The percentage of machine equipment in integrated premises increased during the first part of the period, but it subsequently declined and there was little difference between 1875 and 1904, the beginning and the end of the series. The changes in individual regions were of rather greater amplitude, and in some cases of rather more pronounced trend, but they frequently appear contradictory or fortuitous and are very difficult to understand and interpret. The decrease in spindles in the premises of specialist woollen spinners in Yorkshire might be understood as still further emphasizing the vertical structure proper to the industry, but there was contemporaneously an increase in the number of looms in specialist weaving establishments.[1] The specialist weavers, however, were largely small men who found it within their means to set up a small loom-shop and in many cases to manufacture on commission. The growth of specialist woollen spinning in Scotland is understandable on account of the employment of woollen yarns in hosiery manufacture.

The Census of Production regional returns, reduced to percentages in Table LXI, display the trends for the central part of the inter-war period for the wool textile industry as a whole, but they do not permit us to distinguish between its several branches. These indicate a decline of the West Riding in percentage both of gross output and of numbers employed. The relative decline of the West Riding, however, was only in carpet and rug manufacture and in worsted spinning. The percentage share of Lancashire–Cheshire increased. The trends in the Midlands, in the West of England, and in the minor districts within England and Wales are difficult to elucidate as they were not separately distinguished in the Census of Production returns for 1924 and 1930. There was a substantial increase in the percentage of the combined total of these districts. It is known from evidence previously stated that worsted spinning and, from the evidence of the Census of Population which follows, that carpet-making in the Midlands both increased, and it is probable that the greater part of the increase within this Census of Production group may be attributed to the Midlands. The percentage share of the West of Scotland also increased substantially, and this may be attributed to an expansion of the carpet and rug trades. For the rest

[1] These changes, however, were of only small dimensions

of Scotland the amount of change was small and the evidence again does not permit a statement for individual districts.

TABLE LXVII

Degree of Concentration of Spindles and Looms into Integrated Mills by Districts

WOOLLEN

	Spindles				Looms			
	Great Britain	York-shire	Scot-land	West of England	Great Britain	York-shire	Scot-land	West of England
1875	77·4	78·2	61·0	79·8	83·3	95·9	37·7	92·0
1879	77·5	81·9	57·5	85·8	91·1	94·6	66·6	90·4
1885	79·7	85·1	58·2	87·7	88·7	94·2	67·9	92·2
1890	79·8	85·5	55·0	97·0	86·1	94·1	52·3	90·0
1904	77·7	83·4	56·2	94·5	84·3	92·0	59·7	79·6

WORSTED

	Spindles				Looms			
	Great Britain	York-shire	Scot-land	Mid-lands	Great Britain	York-shire	Scot-land	Mid-land
1875	48·6	51·1	22·8	24·5	47·2	56·7	10·9	12·2
1879	44·9	47·4	14·7	23·8	43·1	53·6	4·7	15·8
1885	41·4	44·5	1·6	16·0	47·6	53·1	2·0	22·1
1890	38·8	42·3	1·5	9·7	42·6	46·3	5·7	7·1
1904	32·1	34·2	8·1	12·5	41·4	43·3	14·8	18·4

The district samples of the Ministry of Labour provide a second set of returns (in this instance annual) for the inter-war period. The material relates to sample firms only, but it gives an index of change. Of the inter-war returns the series goes back to 1926, when the sample of participating firms was greatly enlarged, but there is an earlier series for a smaller sample.[1] For selected years this series of index numbers is set out in Table LXVIII. The wool textile industry as a whole, and each individual branch within it, displayed maximum activity at the trade-cycle crests of 1927–9 and 1937, and minimum activity in the trade-cycle trough following 1929.[2] Of the separate branches the worsted suffered during the depression the most severely, but the carpet suffered scarcely at all. The worsted areas other than the West Riding had a higher level of activity than the West Riding itself, but they are all concerned with hosiery yarn spinning and

[1] The nature of these returns is discussed by Wood, *Journal Royal Statistical Society*, vol. xc (1927), pp. 273–5.

[2] The sample places the trough in 1930, but returns of insured employed for the whole industry place the trough in 1931.

these relative trends are in agreement with the expansion of the hosiery trade. Among the regional areas practising the woollen industry the level of activity in the West Riding was at first lower than in the country as a whole, but its relative position changed during the recovery from the Great Depression and from 1932 onwards the West Riding was consistently the more active. It would thus appear that the West Riding woollen industry was losing ground to the other woollen industries of the country before the Great Depression, but that it subsequently more than recovered this lost ground.

TABLE LXVIII

Regional Trends in Woollen and Worsted Industries. II

Ministry of Labour Sample

January 1926=100

(Returns from which index numbers are constructed refer to numbers employed in May of each year)

	1926	1929	1930	1932	1937	1938	1939
Wool textile	97·9	98·2	70·5	87·8	95·0	84·7	86·9
Worsted	98·7	96·9	59·8	86·9	90·5	82·0	83·6
Woollen	97·1	99·0	80·6	85·3	95·0	82·8	86·0
Carpet and rug	99·0	108·4	107·3	113·7	141·5	125·8	127·2
Worsted:							
West Riding	99·0	96·6	56·7	86·6	89·7	81·2	82·6
Lancashire	102·5	117·3	115·0	127·9	122·7	119·9	130·3
Midlands and West of England	96·9	99·8	91·1	87·3	94·4	87·8	85·3
Scotland	93·3	103·2	98·4	93·2	105·6	93 4	103·2
Woollen:							
West Riding	97·9	98·3	76·3	85·5	98·8	85·7	90·8
Lancashire	95·2	97·2	57·7	86·0	94·0	88·1	87·3
West of England and Midlands	101·4	103·1	95·6	93·8	84·9	78·3	78·6
Wales	32·3	112·0	71·7	96·9			
Scotland	95·6	100·8	95·7	82·1	90·1	75·6	76·1
Worsted:							
Bradford	97·8	93·1	39·6	84·8	89·9	81·2	82·3
Huddersfield	104·0	107·3	52·5	88·9	92·2	83·4	84·8
Halifax	99·0	93 5	76·8	80·8	77·3	72·6	71·1
Leeds	102·9	96·4	72·7	91·4	93·0	83·7	88·8
Keighley	96·2	102·6	82·7	91·0	92·2	82·9	85·3
Heavy Woollen	95·1	101·6	100·6	101·0	109·3	95·0	98·1
Woollen:							
Bradford	102·5	99·8	84·0	93·9	96·2	89·9	88·7
Huddersfield	96·0	91·0	51·5	83·8	100·1	88·4	92·1
Halifax and Calder Valley	99·9	91·5	92·5	88·9	102·2	100 8	102·4
Leeds	94·1	109·9	82·3	83·2	106·3	86·1	93·7
Heavy Woollen	101·0	99·6	92·2	84·1	86·3	74·9	81·3

This discussion of the evidence of regional trends within the wool textile industry thus indicates a general convergence of evidence. The West Riding continued to gain a greater and greater share of

the industry during the nineteenth century, thus continuing the trend of the Industrial Revolution and of the period preparatory to it, but during the twentieth century, though it continued to gain in woollens and in worsted manufacture, it was losing in relative position in worsted spinning and in carpet manufacture. The West of England industry has gradually but steadily declined and the Midlands industry, though also declining at first, has grown steadily since 1891–1901: the one is a woollen, the other a worsted spinning district. The Lancashire industry also declined up to the inter-war period, but it has since retained, if it has not improved, its relative position. After its conversion to a factory industry was completed woollen manufacture in Wales declined. The Tweed Valley of Scotland increased its share of the woollen industry consistently up to 1931, but subsequent statistical material is lacking. During the last pre-war decade the only Scottish district which unquestionably improved its relative position was that practising the carpet and rug industry in the West of Scotland.

Let us now examine the trends of location within the West Riding.[1] The Occupation and Industry Tables of the Population Census are the most useful source for the elucidation of these trends, but it is not possible to obtain a long series owing to the variation in the areas employed for statistical presentation. In 1871 the units were the boroughs, in 1881 and 1891 the urban sanitary districts, in 1901 and subsequently the boroughs again. The continuous series, therefore, dates back only to 1901. Calculated to percentages of the West Riding, these district particulars for the four main county boroughs separately, and for the rest of the West Riding collectively, are set out in Table LXIX. For the wool textile industry as a whole the percentage shares of Bradford and of Halifax declined. The share of Huddersfield fluctuated widely, but comparing the beginning and the end of the series, tended to increase, while the share of Leeds, though it also has fluctuated, tended to remain steady over a term of years. The percentage share of the rest of the West Riding, outside these four county boroughs, increased slightly. The wool textile industry, however, is composite, and these general totals mask different trends exhibited by each branch of the industry. Unfortunately, it is possible to distinguish between the woollen and the worsted industries for these boroughs only for 1921 and 1931, the classification of the 1901 and 1911 returns being occupational and horizontal (into spinning and weaving) rather than industrial and vertical. Within the time-limits thus set by the

[1] Particulars of machinery are available for 1904 and 1918, but they were collected by different bodies, and the districts employed on these two occasions were not identical. The particulars for Yorkshire wool textile mills given annually in *Worrall's Directory* are samples only and, as the size of the sample varies from year to year, they also are unsuitable for the elucidation of trends between district and district.

TABLE LXIX

Trends in Location of Woollen and Worsted Industries within the West Riding

(According to returns of Population Census)

	Bradford	Halifax	Huddersfield	Leeds	Remainder	Total
*Woollen, Worsted and Shoddy**						
1901	25·6	6·8	7·1	6·5	54·0	100·0
1911	24·8	6·0	8·5	6·4	54·3	100·0
1921	24·2	5 2	7·6	5·6	57·4	100·0
1931	24·0	5·9	8·3	6·6	55·2	100·0
Woollen:						
1921	2·1	1 4	14·5	9·3	72·7	100·0
1931	3·2	0·9	11·5	8·2	76·2	100 0
Worsted:						
1921	42·8	8·4	1 9	2·4	44·5	100·0
1931	36·2	9·3	6·4	5·5	42·6	100·0
Carpets and Rugs:						
1921	1·0	39·7	2·4	3·0	53·9	100·0
1931	3·6	29·8	1·8	2·7	62·1	100·0

* Excluding carpets and rugs; dyeing, printing, and finishing; and dealing in raw wool, yarn, and cloth.

The returns for 1931 include those out of work only for the wool textile industry as a whole, the returns for the separate branches of the industry being of those in work Returns for all other years include those out of work as well as those in employment. Returns for 1921 refer to place of work, in other years to place of residence.

material, Bradford's share of the worsted industry greatly declined and the shares of the other three county boroughs greatly increased, particularly in the case of Huddersfield and Leeds, which previously had had only a small share of worsted manufacture. The concentration of the industry into the worsted district would thus appear to have become a little less complete. The trends in the woollen industry were strikingly contrasted. There was a decrease in the percentage share of Huddersfield and Leeds, the woollen manufacturing towns among the four county boroughs, but an increase in the share of Bradford. Whether there was a greater or lesser concentration into large centres of population is obscured by differences in enumeration, being by place of work in 1921 but by residence in 1931. In type of site it is conceivable that there was an intensification of those characteristics of location exhibited by each industry noted above, that the worsted was becoming increasingly an industry of large centres of population, the woollen increasingly one of smaller centres of population. These conclusions take into account the changing proportions of each of these areas to the total population

of the Riding. But the regional concentration of each industry into separate quarters of the West Riding was less acutely marked than hitherto: the worsted was spreading into the woollen district, and, though less clearly, the woollen into the worsted district. This is in sharp contrast to the increasing regional segregation within the Lancashire cotton industry. The main trends in carpet and rug manufacture were a decrease in Halifax and an increase in the other centres, mostly of a small town character, which lie east of Halifax. There was also an increase in Bradford due, partly at any rate, to the making of plush fabric rugs.

The Ministry of Labour sample embodied in Table LXVIII projects these trends to 1939. The Ministry no longer publishes trends based on such a sample. The worsted industries of Huddersfield, Leeds, Keighley, and the heavy woollen district were conspicuously more active, except in an occasional year, than in the West Riding as a whole and, conversely, Halifax and Bradford were less active. This confirms the trend noted above for the 1921–31 inter-censal period. But during the recovery from the Great Depression Bradford was equally as active as the West Riding as a whole, and may be considered to have recovered its position by 1933. These index numbers do not distinguish between the worsted spinning and the worsted manufacturing of the Bradford district; it is likely on other grounds that recovery was in worsted spinning for the hosiery trades and not in worsted manufacturing. Persistent decline was limited, therefore, to the Halifax district. In the woollen industry Leeds and, less consistently, Halifax and the Calder Valley, were more active than the West Riding industry in its total sense. The Huddersfield district was less active before the depression, but more active after it; the heavy woollen district oscillated in precisely the opposite way: the Bradford district prior to the depression was more active and maintained its relative position subsequent to the depression. The district which was losing position on the eve of the war in the woollen industry, therefore, was the Heavy Woollen.[1] The Ministry of Labour sample give no indication of the trends as between large and small towns, but it does confirm in a general way that the segregation of the worsted and of the woollen into separate quarters of West Yorkshire was during the inter-war period becoming less rather than more acute.[2]

[1] During the late war Bradford and Keighley lost ground relative to other districts in the wool textile industry as a whole, while the Heavy Woollen and Huddersfield districts gained ground relatively. Troops required woollens rather than worsteds. The numbers in the industry were everywhere well below the 1939 level.

[2] Since 1939 the West Riding has lost slightly in its percentage of total insured, having 81 per cent in 1939 but 78 per cent in 1948. The West of England also lost, but Scotland gained and so did the North-east Coast. There is to-day a marked shortage of labour and the industry is becoming dispersed to a *minor degree* to areas where female labour is available. Single mills are being started on the North-east Coast, in Furness, South Yorkshire and Lanarkshire.

IV

THE EXPORT TRADE

Historically, the wool textile has been one of the major exporting industries of the country. It developed its bulk of production partly on the basis of export abroad. Some of the trends in internal production noted above have been due to trends in export and import trade. Exports of the several categories of wool textile manufacture for the half-century preceding the late war are set out in Tables LXX, LXXI and LXXII. The worsted trade, involving combed tops, worsted yarns, and worsted tissues, presented some particularly informative trends during the inter-war period. The export of tissues declined over the whole period up to 1939, recovering only temporarily in 1929 and 1937. The decline in the export of worsted yarns did not develop until later, but it too fell after 1927, with only a temporary recovery in 1933. The export of combed tops increased rather than declined and the increase was most striking when the export of both yarns and tissues was falling. It would thus appear that export has worked back from tissues to yarns and later from yarns to tops, in each case reaching back one stage nearer to the raw material. This has implied a decline in the activity of British worsted manufacture, for semi-products have been exported instead of the finished product and the semi-product chiefly involved ultimately came to be the preliminary one of combed tops. Thus, worsted weaving and, later, worsted spinning have both been affected. The export of woollen yarn and woollen tissues has not displayed these movements quite as clearly. Export of woollen tissues and especially of woollen yarns was higher during the first decade of the inter-war period than before it, but during the Great Depression export of tissues fell while export of yarn was maintained. In 1946 exports of woollen and worsted tissues together approached the 1939 level very much more closely than the export of cotton piece goods. For many centuries, ever since the earlier Middle Ages, British exports of finished woollen and worsted cloths had exceeded imports. But imports gradually increased during the twentieth century with the development of continental industries. They suddenly declined to a mere fraction of their 1931 level owing to the operation of the Import Duties Act of 1932. There had been some recovery in the volume of import since that date and prior to 1939, but the level had remained substantially low. In 1935, according to the Census of Production returns, the percentage of the home market held by British-made products was 99·7 for tops, 99·7 for yarns, and 98·7 for woollen and worsted tissues; in 1930 it had been 94·7 for yarns and 85·2 for tissues, and in 1924 96·5 and 89·0 respectively. Between 1924 and 1930 imported tissues had thus been increasing their share of the home market. The Import Duties Act of 1932 clearly reversed this trend

TABLE LXX

Trends in Export of Wool Tops and of Woollen and Worsted Yarns from the United Kingdom

(in million lb.)

	Combed wool tops	Woollen yarns	Worsted yarns	Other yarns	Total yarns
1890–4	9·5	1·2	44·9	14·2	60·3
1895–9	22·4	1·1	59·5	16·4	77·0
1900–4	35·2	1·6	52·9	17·8	72·3
1905–8	36·1	2·3	51·2	22·5	76·0
1909–13	41·9	4·7	57·2	25·1	87·0
1920–4	36·0	7·9	34·3	9·4	51·7
1925–9	35·0	6 7	39·2	14·8	60·7
1930–4	37·2	6·6	32·7	10·3	49·7
1935–9	42·9	6·7	26·2	8·2	41·1
1950	73·0	6·1	23·9	5·2	35·2

TABLE LXXI

Trends in Export of Woollen and Worsted Tissues from the United Kingdom

(in million linear yards)

	Woollen tissues		Worsted tissues		Total woollen and worsted tissues	Flannels and delaines	Carpets
	All wool	Mixed	All wool	Mixed			
1890–4	19·4	30·8	32·1	108·0	190·3	10·5	9·4
1895–9	20·0	33·0	32·4	93·3	179·8	11·1	7·9
1900–4	20·6	31·4	21·6	80·2	153·9	9·7	8·2
1905–8	31·3	46·9	22·1	72·6	172·9	8·4	8·2
1909–13	38·7	56·9	23·3	55·4	174·3	7·8	8 8*
1920–4	50·7	54·0	23·1	25·0	152·8	8·0	6·4
1925–9	42·7	50·1	18·2	16·9	129·3	6·9	6·6
1930–4	23·5	24·4	13·8	11·6	73·7	5·2	4·0
1935–9	27·4	24·7	14·7	15·2	82·9	6·0	6·2
1949	40·6	12·1	25·6	4·6	82·9	—	10·5

* For this and subsequent periods returns for carpets are in square yards.

From 1925 'tissues wholly or mainly of mohair, alpaca, and cashmere (not being pile fabrics)' are separately classified, but they are included in the above totals to make them comparable with preceding periods.

From 1920 returns are given in square yards, but these have been converted, except for carpets, into linear yards to make them comparable with those of earlier periods. The conversion formulae employed are those used by the Balfour Committee, i.e. for woollens, 4 square yards=3 linear yards; for worsteds, 5 square yards=4 linear yards; for flannels, 7 square yards=10 linear yards.

and secured a virtual monopoly of the home market for the British manufacturer. Import had not been of the whole range of woollen and worsted tissues, but chiefly of those lighter cloths under 12 ounces per square yard, described as women's dress goods.[1] These competed

[1] *Report* of the Woollen and Worsted Committee, Cmd. 3355 (1929).

with the goods made in the Bradford and Keighley districts, both in the British market and abroad, and were doubtless the chief factor in the decline of the worsted industry in the Bradford district which has been noted above. The virtual exclusion of these imports by the 1932 Act may have contributed to the recovery of the Bradford district after the Great Depression, but the home market for worsted dress goods of this kind had in any case declined.[1] The imported cloths were admittedly less durable than those made in Britain, but the demand in women's dress goods had shifted away from 'everlastings'. The men's wear trades have scarcely been affected by competition from abroad. It is not without significance that, while fashions in women's dress goods are set by France, fashions in men's wear are set by Britain.

TABLE LXXII

Output of Woollen and Worsted Industries for Home and Export Markets

(Census of Production returns)

In million lb.	1907	1912	1924	1930	1935
Combed tops—home market .	208	260	244	196	251
export market .	36	45	41	29	56
Worsted yarn—home market	106	147	170	130	194
export market	80	57	45	32	33
Mohair yarns, etc.—home market	—	21	16	11	7
export market	—	25	12	12	10
Woollen yarns—home market	257	309	304	195	291
export market	3	6	8	5	8
Woollen and worsted tissues.					
Home market—*million linear yards*	255	295	—	—	—
million square yards	—	—	241	202	299
Export market—*million linear yards*	193	180	—	—	—
million square yards	—	—	225	114	110

To convert from square yards to linear yards, multiply by 0·75 for woollen tissues and by 0·8 for worsted tissues.

But the restriction in output in the woollen and worsted industries as a whole was during the inter-war period and is to-day very much less than the restriction in the output of the cotton industry. Indeed, the International Labour Office report on the *World Textile Industry* wrote of 'the United Kingdom's maintenance of her relative status'.[2] The cotton industry had exported a greater percentage of its output and had consequently made itself much more vulnerable to foreign competition. Even in 1907, when a greater percentage of output was exported than subsequently, export as a percentage of production was 1·0 for woollen yarns, 43·1 for worsted yarns, and 43·0 for woollen and

[1] The increasing demand of yarns for hosiery manufacture probably contributed more to the recovery.

[2] *The World Textile Industry*, vol. 1 (1937), pp. 118–19.

worsted tissues. Table LXXII displays the maintenance of production for home consumption, except during the Great Depression, and the fall in export abroad. In fact, production for home consumption of combed tops and of worsted yarns has increased.[1] Long-term decline in the output of the industry as a whole, apart from short-term changes and apart from sectional differences, is thus entirely due to declining export. The woollen and worsted trades benefited by the technical pioneering of British industry during the eighteenth and nineteenth centuries, and they have suffered by industrial development, particularly in countries which had formerly served as markets for British goods. This is the long-term trend. Nevertheless, this decline in export of finished tissues, real though it be, was, in a short-term sense, less than the decline in export of tissues from several other countries. 'In the general process of contracting trade,' declares the Report of the International Labour Office, 'the United Kingdom has suffered perhaps less than most other countries.'[2]

[1] Output of worsted yarns was 164 million lb. in 1947, 194 in 1948 and 208 in 1949. In 1950 it was more nearly approaching the level of 1935. Output of woollen and worsted fabrics, including blankets, was 438 million square yards in 1948, 461 in 1949 and in 1950 this figure appears to have been maintained. This output was in excess of that of 1935. *Board of Trade Journal*, vol. CLIX (1950). Exports reached pre-war levels in 1948, except in yarns.

[2] *The World Textile Industry*, vol. I (1937), p. 144.

CHAPTER X

COTTON MANUFACTURE

I

THE GENESIS OF THE INDUSTRY

THE manufacture of fabrics consisting entirely of cotton, as has been pointed out above, dates in England only from the end of the eighteenth century. The new manufacture was, in fact, essentially a product of the Industrial Revolution, for it was not until the invention of Arkwright's water-frame and of Crompton's mule that purely cotton fabrics could be woven.[1] It was at this time widely diffused. 'It seemed, late in the eighteenth century,' A. P. Wadsworth has declared, 'as if the cotton manufacture would spread over the whole of the British Isles.'[2] This wide dispersion was facilitated by the previously diffused distribution of textile working, whether in wool, linen, or silk, and by the movements then in progress by means of which one raw material was being substituted for another. At the same time that Lancashire was turning from wool and fustian to cotton, East Anglia was developing a silk manufacture to compensate itself in part for the loss of the worsted to the West Riding[3] and the Glasgow and Paisley weavers were adding silk gauze to their fine linens and, at the very end of the century, cotton muslins as well.[4] During the Industrial Revolution of the late eighteenth and early nineteenth centuries there was cotton-working in Nottingham—where Hargreaves, the inventor of the spinning jenny, had what was claimed to be the first cotton-mill in the world;[5] in Derbyshire—the spinning-mill of Richard Arkwright senior was at Cromford and of Richard Arkwright junior at Bakewell, both in the heart of the Peak District limestone; at Kendal and Carlisle, at Belfast, in North Wales, in the Lower Clyde Valley, and elsewhere in the Lowlands of Scotland—though the industry was usually financed from Glasgow; as well as in Lancashire and the adjoining parts of Cheshire, Derbyshire, and the West Riding. This was the experimental phase in the localization of the factory cotton industry. It will be noticed that practically all these districts were

[1] G. W. Daniels, *The Early English Cotton Industry* (1920). G. W. Daniels, 'Industrial Lancashire Prior and Subsequent to the Invention of the Mule', *Journal Textile Institute* (1927). Special issue in association with the Samuel Crompton Centenary.

[2] A. P. Wadsworth, 'The Early Factory System in the Rochdale District', *Trans. Rochdale Literary and Scientific Society*, vol. XIX (1935–7).

[3] J. H. Clapham, *An Economic History of Modern Britain: Early Railway Age* (1926), pp. 44–5.

[4] H. Hamilton, *The Industrial Revolution in Scotland* (1932), pp. 118–20.

[5] G. W. Daniels, *The Early English Cotton Industry* (1920), p. 97.

in western Britain, which has both water-power and a humid climate, but it was the water-power rather than the humidity that was then the conscious localizing factor.

After the nineteenth century had begun the phase of experimental localization in an extended terrain ceased. The centrifugal movement was replaced by a centripetal one, the outliers of cotton manufacture were withdrawn and the industry became concentrated more and more on Lancashire. The decay in the outlying districts may be attributed in many cases to lack of coal, which had become the power basis of the industry; but this cannot be held responsible for the decline in the West of Scotland manufacture. It is ascribed by Dr. Hamilton, firstly, to the fact that fine goods were the staple of Scottish production, and that these were not in demand in the East, the great market which took more and more of Lancashire's cotton exports during the course of the nineteenth century; and, secondly, to the effects of the cotton famine of the 'sixties. 'The shock thus sustained served to direct attention to the superior advantages and greater potentialities of the metal industries, which now expanded with greater rapidity than ever'.[1] The West of Scotland has geographical advantages equal with Lancashire: it has coal, it has humidity, it has a great port with overseas connexions for the import of raw cotton and for the export of the finished fabric. The concentration of cotton manufacture in Lancashire in the nineteenth century was, in fact, one example, perhaps the supreme example, of the regional specialization of textile industry that was proceeding at the time, whereby woollen and worsted came to be concentrated into the West Riding, linen into the North of Ireland (apart from Fife and Forfar), and cotton into Lancashire. Regional specialization went even further. Gradually there developed the internal geographical separation of spinning and weaving south and north of Rossendale respectively. This happened, as Prof. Jewkes has shown, mainly after 1850.[2]

II

THE FACTORS AFFECTING LOCATION

This brief recapitulation of the historical geography of the cotton industry will serve as a background to the systematic analysis of its geographical distribution at the present day. Of the firms spinning or weaving cotton in Great Britain in 1936, 96·7 per cent were in Lancashire and the adjoining parts of Cheshire, Derbyshire, and the West Riding, 1·3 per cent in the West of Scotland, and 2·0 per cent elsewhere. The main seat of the industry is clear. Moreover, within Lancashire and the adjoining counties the distribution is strictly

[1] H. Hamilton, op. cit., p. 149.

[2] J. Jewkes, 'The Localisation of the Cotton Industry', *Economic History*, vol. II (1930), pp. 91–106.

confined. Fig. 62 gives the distribution of all spinning-mills and weaving sheds in Lancashire in the year 1936, according to the returns in *Worrall's Directory*. A systematic discussion of the limits as brought out by the map will give an insight into the localizing factors which have determined the present distribution of the industry as a whole within Lancashire and its borders. The separate regional distribution of distinct processes will be considered later. The physical factors will be considered first. These are the humidity of the air, the softness of the water, coal, and water-power. There are two problems to resolve: first, the localization in Lancashire in contradistinction to other parts of Britain, and, second, the limitation to East Lancashire, South-east Lancashire, and Rossendale,[1] and the virtual absence in West Lancashire.

The humidity of Lancashire has often been stressed as a localizing cause of cotton manufacture. The thread, whether the roving that is being spun or the yarn that is being woven, breaks comparatively easily, and one of the main tasks of the spinner and of the weaver minding power-driven machinery is to piece together the broken ends. Breakages vary in frequency, among other factors, with the humidity of the air. The temperatures and humidities required in cotton spinning are approximately 70°–80° F. temperature and 50–60 per cent relative humidity.[2] The ascertained temperatures and humidities in a sample of cotton weaving sheds have been given in the preceding chapter, the averages for five sheds being 70°–75° F. temperature and 76–77 per cent relative humidity. When cotton was a handicraft industry it was carried on largely in damp cellars and when the earliest machines were driven by water-power it was located in damp valley bottoms. To-day artificial humidifiers are in use and the humidity is adjustable to the standard required, but before their invention natural humidity was of great importance and must have functioned as one of the factors localizing the industry.

The geographical variation in relative humidity between different parts of Great Britain has been indicated in the preceding chapter. The variations within western and northern Britain, which have the highest humidities, are comparatively slight, and it will be recalled

[1] As these descriptions will be used throughout it is necessary to define what is meant by them. East Lancashire is the local regional name for the line of towns extending from Blackburn to Colne South-east Lancashire is the area having Manchester as its centre and comprising the ring of towns from Wigan and Bolton to Ashton and Stockport, and including North-east Cheshire and North-west Derbyshire. Rossendale lies between East Lancashire and South-east Lancashire, thus defined.

[2] F. Scarisbrook, 'Humidity in Weaving Sheds', *International Cotton Bulletin* (1924), p. 124. See also *Fourth Interim Report* of the Joint Advisory Committee of the Cotton Industry (1947).

Maps drawn from data in *Worrall's Directory*. Each dot is placed on the site of one cotton spinning mill (A) and of one cotton weaving shed (B). See notes under Fig. 58

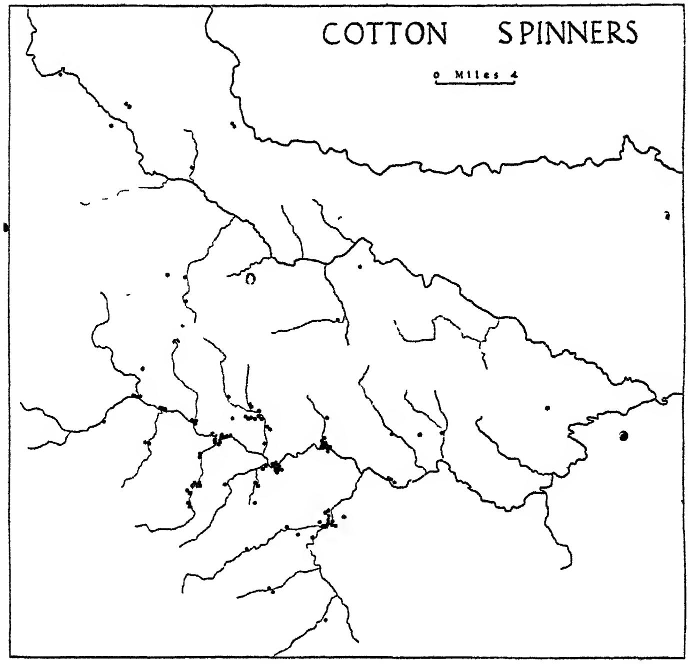

Fig. 61A

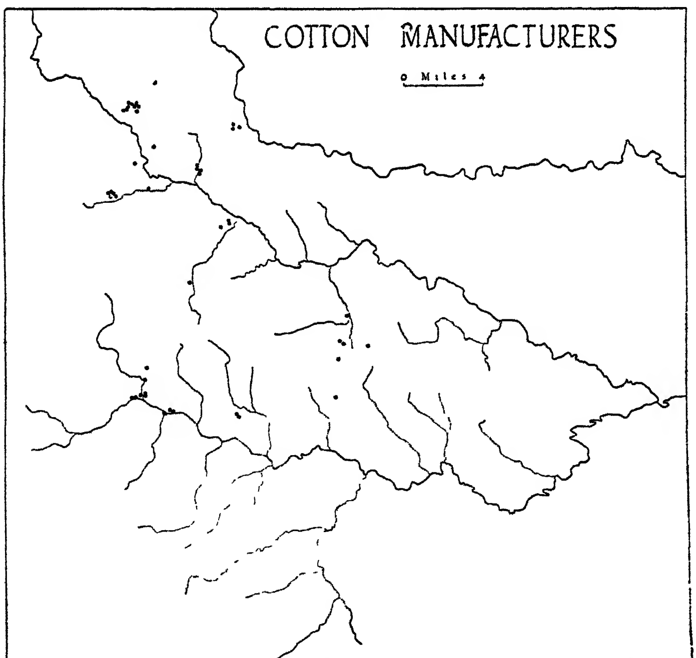

Fig 61B

COTTON SPINNERS AND COTTON MANUFACTURERS IN WEST YORKSHIRE

that until the middle of the nineteenth century the cotton industry had a wide distribution in these districts. The distribution of relative humidity within Lancashire itself has been studied by H. W. Ogden.[1] He concludes that the limitation of the cotton industry to the eastern part of the county is not based on greater humidity, for the relative humidity of the West Lancashire coast, which had then one cotton-mill, is equally as high as the relative humidity of the cotton manufacturing towns with their hundreds of cotton-mills. Averages calculated afresh for a homogeneous series of years and referring in each case to 9 a.m., confirms Ogden's conclusions. Southport and Blackpool on the coast have as high a humidity as Bolton, Burnley, or Manchester.[2] The detailed localization of cotton manufacture within a particular part of Lancashire is not, therefore, due to relative humidity, for the humidity of districts which practise no cotton manufacture is as high as the humidity of the districts which do. These conclusions are based on observations at 9 a.m. At midday in summer inland stations in Britain have lower relative humidities than coastal stations. The conclusion arrived at above is thus reinforced.

The second of the physical localizing factors is the softness of the water. Variations in water hardness over Britain have been examined in the preceding chapter. The relative softness of water in different parts of South Lancashire has also been studied by H. W. Ogden, and he points out the marked difference between the Permo-Triassic plain of West Lancashire and Cheshire, on the one hand, and the Millstone Grit and Coal Measure Pennines and their foothills, on the other. Fig. 63 has been constructed from data from nineteen water authorities and from a few firms raising water from wells. The figures show the hardness of water on Clarke's scale; that is, as parts of calcium carbonate per 100,000 parts of water. The map confirms Ogden's conclusions. The differences require, however, some further consideration in order to avoid false assumptions with regard to the causes of these differences. The West Lancashire analyses are of water from pumping stations and wells, that is, of water which has remained underground for some time and has been able to dissolve mineral constituents in the solid rock. It is well known that hardness increases with depth, and in West Lancashire the higher values are from pumping stations and the lower values from wells. The analyses in the eastern half of Lancashire, on

[1] H. W. Ogden, 'The Geographical Basis of the Lancashire Cotton Industry', *Journal Manchester Geographical Society* (1927), Figs. 3, 4, and 16.

[2] I am greatly indebted to the Superintendent of the M.O., Edinburgh, for the Renfrew returns, to the Medical Officers of Health of Burnley, Blackburn, and Blackpool, and to the Curator of the Chadwick Museum, Bolton. The returns for Southport, Manchester, and Kew, have been abstracted from the *Monthly Weather Reports* of the M.O. The averages for Preston for an earlier terms of years, kindly supplied by the Preston M.O.H., are identical with the averages of Bolton for the same years. Not all of these stations have been included in Fig. 57.

the other hand, are of water from reservoirs which collect immediate run-off from rainfall on Pennine moors, that is, of water which is mainly surface water which has not been underground. The arithmetical average of analyses from seven wells and boreholes in

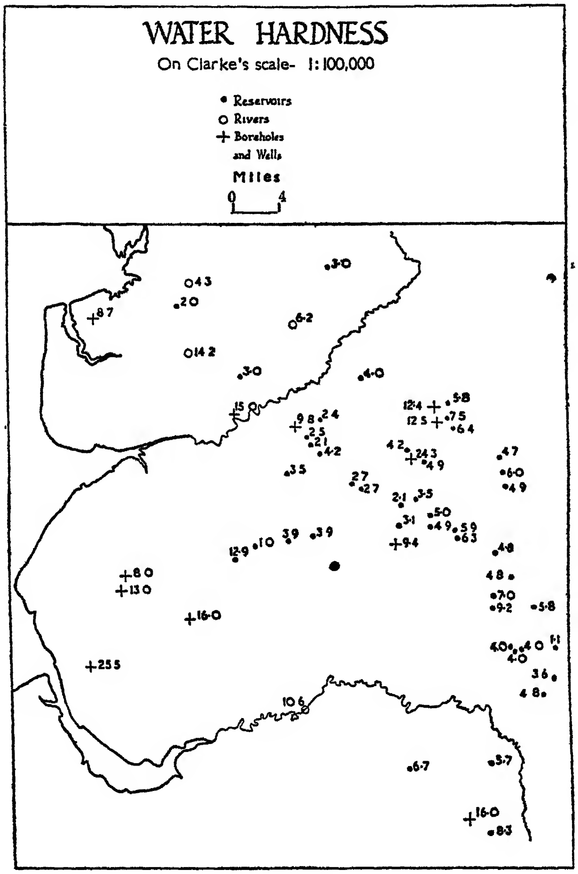

Fig. 63

WATER HARDNESS IN PARTS OF LANCASHIRE AND CHESHIRE

Expressed in terms of Clarke's scale 1 : 100,000 Dots locate analyses from reservoirs, hollow circles analyses from rivers, crosses analyses from bore-holes and wells. Map drawn from data supplied by water boards and by water supply authorities.

West Lancashire is 15·1 Clarke and the average from forty-six reservoirs in eastern Lancashire is 4·4 Clarke. It is agreed by all the water engineers I have consulted that stream water in this eastern district has a hardness little, if any, greater than the reservoir analyses mapped. But wells and boreholes in this district show a

much greater degree of hardness, the average for nine analyses being 12·5 Clarke. This is almost as high as the average for West Lancashire wells and pumping stations. The difference in water hardness between the Millstone Grit–Coal Measures, on the one hand, and the Permo-Triassic, on the other hand, is thus due to the mainly surface waters of the one and the underground waters of the other, perhaps even more than it is due to the different chemical constitution of the two rock series. It is now possible for certain parts of West Lancashire, for example, in the areas served by the Liverpool Corporation and by the Fylde Water Board, to obtain water from moorland reservoirs equal in softness to that supplied to industry in eastern Lancashire. But by the time this became possible, the experimental phase of the localization of the cotton industry had passed away, and it had become firmly rooted in an area where soft water from surface streams was immediately available.

Water is used in the cotton industry, apart from use in boilers and condensers, mainly in bleaching, dyeing, and printing. Spinning and weaving-mills use water drawn from streams (stored in lodges) and from canals, but many use reservoir water, supplied by a water authority, to supplement stream and spring water when the level of water in the lodges is low.

The third and fourth factors are coal and water-power respectively. Only a few mills now use water-power, and then only in part, for the intermittent and uncertain supplies of water available for this purpose are unsuited to the needs of the modern age. According to the Census of Production for 1924 only 0·5 per cent of the h.p. used by spinning-mills and weaving sheds was then generated by water-power. But the initial localization of many mills dates back to the time when they were driven by the water-wheel, although they are now driven by steam generated by coal. 'Within fifteen years of Arkwright's venture at Cromford the glens of Scotland and the valleys of Wales, as well as every considerable stream on both sides of the Pennines, were being turned to industrial uses.'[1] The floor of many a Pennine valley, in Lancashire as well as in the West Riding, is fully occupied even to-day by an unbroken succession of mills, mill dams (or lodges), and mill sluices. These mills still retain their water rights, though they may not now draw upon them extensively. It was estimated that in 1788 there were in Great Britain 145 cotton-spinning mills run by water-power, though doubt has been cast on the accuracy of this figure. Steam began to be employed the following year,[2] 'but water-power remained for another generation the chief agency, and the competition amongst industrial

[1] G. Unwin, A. Hulme, and G. Taylor, *Samuel Oldknow and the Arkwrights* (1924), p. 21.

[2] This is the date given by Ure of the introduction of the steam engine into the Manchester cotton industry. But see Daniels, *Early English Cotton Industry*, p. 81. There had been a steam-driven cotton mill in Nottinghamshire four years before.

capitalists with considerable resources to secure water-power in the most favourable situations and to develop it by ambitious feats of engineering is one of the most remarkable features of the last decade of the 18th century'.[1] The Boulton and Watt steam-engine which Samuel Oldknow had set up in 1791 was in a factory in Hillgate, in Stockport, above the streamside and so unsuitable for the application of water-power. By 1836, less than two generations after, the steam-engine had far outstripped the water-wheel. In that year, according to a report presented before the Manchester Statistical Society in 1837, the cotton-mills of the Bolton district had eighteen water-wheels but ninety-eight steam-engines.[2]

The erection of a steam-engine implied facilities for obtaining coal. The lower Pennine slopes and Rossendale, save its flagstone summits, are formed of the Lower Coal Measures and the Mountain Mines of this series were extensively worked to supply the stream-side mills with coal and their workers with household fuel. The stream-side situation among the hills could persist. But the new power allowed the towns on the Middle Coal Measures in the plain to develop at a much faster rate, for the steam-driven mills could be aggregated in the towns in a way that water-driven mills strung along a stream-side could not be. By 1824–5 mills were being built in Rochdale, for example, and a new town was being created. The cotton industry is to-day closely localized on the Lower and Middle Coal Measures; there are some cotton-mills on the Millstone Grit, but very few on the Trias. In the early nineteenth century, when the steam-engine consumed enormous quantities of coal to produce a given amount of power, the coal-using cotton-mill was necessarily closely localized to the coalfield. Boilers are fired with slack coal, the cheapest of all, but the most expensive to transport relative to its value. Location near coal is not now so essential owing to improvements in boiler efficiency and in transport, and owing to changes in power generation and distribution due to the electric grid, but the industry stills depends very much more on steam-power than on the electric drive.[3]

The physical factors of soft water, water-power, and coal thus

[1] Unwin, Hulme, and Taylor, op. cit., p. 119.

[2] T. S. Ashton, *Economic and Social Investigations in Manchester, 1833–1933* (1934), p. 19. In 1839 the cotton mills of the Rochdale district had 1993 h.p. generated by steam and 185 h.p. generated by water (A. P. Wadsworth, *Trans Rochdale Literary and Scientific Society*, vol. XIX (1935–7), p. 155).

[3] In 1927 the average cotton mill with four Lancashire boilers consumed 3,000 tons of coal per annum. At this date the average thermal efficiency of Lancashire boilers in cotton mills was 10 to 12 per cent with some small plants as low as 8 per cent, while the average thermal efficiency in British power-stations was perhaps 12 to 14 per cent. The gap between efficiency of steam generation in cotton mills and of electricity generation in power-plants has probably widened since 1927 (D. Brownlie, 'Steam Power in Evolution', *Journal Textile Institute* (1927), Special Issue). For an account of the Lancashire boiler see H. W. Dickinson, *A Short History of the Steam Engine* (1939).

limit the industry to the eastern side of Lancashire. West Lancashire has only humidity to favour it. These factors have continued to localize the industry, though their influence is not now so commanding as formerly. Humidity can to some extent be produced at will and soft water and power can be transported. But they were very powerful in the formative period of localization, and it is in reference to conditions at that time rather than at the present day that the close localization of the industry is to be understood. Once established and once it acquired an economic momentum, it persisted on its original site. The limited effect of raw materials in localizing the textile industries has been developed in the opening paragraphs of Chapter IX.

The localization of cotton manufacture within Lancashire and its borders has been influenced by the human as well as by the physical geography. The Millstone Grit soils are agriculturally poor and the Coal Measure soils, except where improved by drift, are little better. They were scantily peopled during the Middle Ages when farming was the basis of community life and Rossendale, for example, was then a royal chase. But, particularly from the sixteenth century onwards these poor lands were gradually reclaimed by generation after generation of small-holders who eked out the meagre produce of their stony fields by textile working, at first of wool, as in the West Riding. Dr. G. H. Tupling calculates that in 1608, in the Forest of Rossendale, two-thirds of the properties were of less than thirty customary acres and two-fifths of less than fifteen acres.[1] These holdings had more grass than arable and were insufficient to supply a family with corn. Fustians replaced woollen cloths during the seventeenth and eighteenth centuries in much of South-east Lancashire, but woollens remained the staple of manufacture in Rossendale and East Lancashire until they were replaced by cotton in the early nineteenth century. It is not certain what proportion of the population consisted of 'farmer-weavers' and what proportion followed farming or industrial occupations alone. For Rossendale, at the beginning of the eighteenth century, Dr. Tupling computes from occupations recorded in parish registers 'that half of the total population was dependent on the textile trade'.[2] Radcliffe reported that of the fifty to sixty farmers in Mellor, near Stockport, in 1770, only six to seven did not get their rent partly paid by spinning and weaving,[3] and that there were many more cottagers entirely dependent on manufacture and whose only agricultural earnings would be at hay-time and at harvest. The population of the sterile Pennine hillsides had clearly grown beyond their capacity to support a purely agricultural population. In the Lancashire Plain, with better soils,

[1] G. H. Tupling, *The Economic History of Rossendale* (Chetham Society), vol. LXXXVI (1927), p. 162.

[2] Tupling, op. cit., p. 178.

[3] Unwin, Hulme, and Taylor, op. cit., pp. 160–1.

a lesser rainfall, and a sunnier climate, there were much greater agricultural possibilities and a purely agricultural population could attain much greater densities. There were few cottagers who had no land.[1] There was not the same incentive to take up a textile manufacture and, although it was not absent, it often took other forms, such as sail- and rope-making at Warrington, Liverpool, and in the tiny ports of the Fylde coast.[2] The two areas became socially, as well as economically, distinct.[3] This differing economic and social evolution of the West Lancashire Plain helped to limit the cotton manufacture, arising out of this previous wool and fustian environment, to the Pennine hillsides and foothills. Once its development began, it acquired greater and greater momentum. The elaborate economic organization, the physical plant, and the social and technical experience thus acquired, secured its persistence.

The development of the cotton industry in Lancashire, with its dependence on foreign trade for raw material and market, was facilitated by the existence of the port of Liverpool. The port had overseas connexions already established by the end of the eighteenth century, particularly with the Americas, by that time the source of the raw material. In the pre-Industrial Revolution phase, when Lancashire made fustians of linen warp and cotton weft, linen yarn was imported through Liverpool from Ireland, but the earliest raw cotton supplies, from the Levant, had come by way of London. It was not until raw cotton was imported from the West Indies, and later from the North American mainland, that Liverpool began to handle the trade. Liverpool's trading connexions with the East had to await the abolition of the East India Company's monopoly of the Indian trade in 1813, but from thenceforward her shipping services with India and, after 1833, with the Far East, greatly facilitated the development of the Eastern market, which took such a large proportion of Lancashire's cotton exports during the late nineteenth century. Liverpool, therefore, greatly helped in the development of the cotton industry, if it did not help to create it. The second earliest canal (the Bridgewater), and the second earliest railway in Britain (the Liverpool and Manchester) had been built to link the manufacturing districts of Lancashire with Liverpool, their port. The cotton industry, like other expanding trades of the time, could breathe only if the channels of communication were kept clear.

[1] J. H. Clapham, 'Tithe Surveys as a Source of Agrarian History', *Cambridge Historical Journal*, vol. I (1924), pp. 205–6.

[2] For the zonal distribution of the particular varieties of textile manufacture, see the maps in A. P. Wadsworth and J. de L. Mann, *The Cotton Trade and Industrial Lancashire, 1600–1780* (1931).

[3] For the development of this theme, see F. Walker, *Historical Geography of South-west Lancashire* (Chetham Society), vol. CIII (1939), New Series.

III

THE HORIZONTAL ORGANIZATION AND ITS GEOGRAPHICAL EXPRESSION

Not only is the cotton industry as a whole closely localized, but different processes of the industry have each their separate distribution. The Lancashire cotton is a classic example of a horizontally organized industry. Of the total spindleage in 1936, 83 per cent was in mills spinning only, and of the total loomage, 72 per cent in sheds weaving only. Only 17 per cent of the spindles and 28 per cent of the looms were in *premises* which combined both processes.[1] I calculated these proportions from the returns in *Worrall's Directory* for 1936. An analysis for 1949 has recently been made. Including both single unit and multiple unit firms, 92 per cent of spinning spindles and 75 per cent of looms were in the hands of specialist spinners and weavers respectively. Each section has still, at the time of writing, its own employers' organization and its own separate trade unions. The import of raw cotton was until recently in the hands of firms belonging to the Liverpool and Manchester Cotton Associations. The bleachers, dyers, printers, and finishers are, with some minor exceptions, completely independent of the spinners and manufacturers. The merchanting of finished goods is, save for a few firms, in the hands of those who do not engage in manufacture of any kind. Even packing is a specialized business. The Yorkshire worsted industry has a similar horizontal organization, but the cotton industry, unlike the worsted, has each of its parts territorially segregated. Its horizontal organization has acquired a geographical expression.

The buying of raw cotton has been concentrated into the two ports of Liverpool and Manchester, and it is to be expected that for the sake of industrial efficiency this will continue. The Act which set up the Raw Cotton Commission in 1947 enacted that the principal office shall be in Liverpool and a branch office in Manchester.[2] When cotton was used only for fustian-making, it was sold to spinners mainly by dealers living in the spinning districts and in Manchester. The dealers bought from Liverpool merchants who imported raw

[1] The definition of a combined mill presents some difficulty. That adopted in this book is one where spinning and weaving are combined on the same *premises*. This is not necessarily the same as a combined *firm* which may practise spinning and weaving in separate premises. The use of the mill rather than of the firm as the unit is not only more useful geographically, but it also avoids difficulties of classification such as that presented by the Lancashire Cotton Corporation, which, if reckoned as a combined firm, as it was in 1936 when it had looms as well as spindles, would distort all calculations. By 1946 it had ceased to do weaving. My calculation for 1936 referred to premises and not to firms: calculations by others referred to firms. See S. J. Chapman and T. S. Ashton, 'The Sizes of Businesses, mainly in the Textile Industries', *Journal Royal Statistical Society*, vol. LXXVII (1914). R. Robson, *Manchester Statistical Society* (1949).

[2] The Cotton (Centralized Buying) Act, 10 and 11 Geo. 6, Ch. 26, Sec. 5 (2).

cotton, together with other commodities. With the growth of the cotton manufacture properly so-called, and with the increasing quantities of raw cotton required in consequence, specialist cotton brokers domiciled in Liverpool began to handle more and more of the trade. 'This probably began about 1810, and developed rapidly after the opening of the Liverpool and Manchester Railway in 1830. Many of the Manchester dealers moved to Liverpool, while other new brokers there were relatives of dealers or spinners.'[1] The formation of the Manchester Cotton Association did not come until 1894, that is, it was not possible until the construction of the Manchester Ship Canal created the Port of Manchester. Both associations were therefore located at the importing ports and were intimately bound up with the facilities which a port provides for importing raw cotton and warehousing it preparatory to its use. But, while the Liverpool Cotton Association consisted entirely of merchants and brokers, the Manchester Cotton Association consisted of merchants, brokers, and spinners. Manchester, though not an important spinning town itself, is the geometrical and geographical centre of the spinning district, and it was in fact the spinners, anxious to be independent of the Liverpool brokers, who were largely responsible for the creation of the Manchester Cotton Association.

The separate and strongly localized distribution of spinning and weaving is equally striking. Fig. 62 brings out this regional distribution clearly. In 1936 90 per cent of all spindles in Lancashire were in South-east Lancashire and 10 per cent in East Lancashire and Rossendale, while 74 per cent of all looms were in East Lancashire and Rossendale and 26 per cent in South-east Lancashire. The concentration[2] has been progressive since the middle of the nineteenth century, by which time the factory had come to dominate the cotton industry, both in respect of (*a*) the elimination of the combined firm and (*b*) the geographical segregation of separate processes. The combined *firm* was prominent until 1884, when, according to the calculations of Prof. S. J. Chapman and Mr. T. S. Ashton (as they then were), 41 per cent of the spindles and 58 per cent of the looms in the Lancashire cotton industry were in combined firms.[3] By 1911, however, the combined *firms* had only 23 per cent of the spindles and 35 per cent of the looms, and in 1936 the combined *mills* had 17 per cent of the spindles and 28 per cent of the looms.[4] The present proportions for *firms*, given in the Report of the Board of Trade Working Party, are 18·5 per cent of the spindles and 22·5 per cent of the looms. The geographical segregation developed earlier. By 1884, East Lancashire and Rossendale had

[1] J. A. Todd, *The Cotton World* (1927), p. 90.

[2] S. J. Chapman, *The Lancashire Cotton Industry* (1904), pp. 161–3.

[3] Chapman and Ashton, op. cit., p. 538.

[4] Combined mills and combined firms are not synonymous. See footnote 1 on p. 472 above.

62 per cent of the looms and South-east Lancashire 78 per cent of the spindles.[1] In 1929 East Lancashire and Rossendale had 73 per cent of the looms and South-east Lancashire 88 per cent of the spindles. In 1936 the proportions were 74 and 90 per cent respectively.[2] The regional differentiation of spinning and weaving has been equally progressive. The contrast with the Yorkshire worsted industry is clear. The worsted industry, though horizontally organized, has not this territorial segregation of spinning and weaving. Worsted spinners and worsted weavers, though separate firms, are to be found in the same towns. This is what would naturally be expected, for the arrangement permits greater technical efficiency by concentration on one particular set of processes and eliminates as much unnecessary transport as possible, though it is by no means the rule for a worsted weaver to draw his yarn always from a spinner in the same town. It is the separate geographical distribution of cotton spinning and cotton weaving that requires explanation.

The historical origins of this separate distribution have been traced by Prof. Jewkes and an explanation attempted in the light of the economic and labour conditions of the time. Using the returns given in the Factory Inspectors' report for 1841,[3] Jewkes concludes that at this time 'only the first signs of the geographical separation of spinning and weaving . . . had yet appeared. The most important type of firm was the vertical firm'.[4] Using the returns in *Worrall's Directory* for 1884, quoted above, however, Jewkes concludes that by that date the geographical separation of the two groups of processes had already become marked. The origins of the separation lie therefore between 1841 and 1884. Spinning was from the first mainly localized in South-east Lancashire. Moreover, spinning became a factory industry before weaving, and, as a result, the production of yarn outpaced the production of cloth. There was a big reserve of hand-loom weavers in Rossendale and East Lancashire, and, to the north of these districts, in the Pennine dales, there was a reserve of agricultural labour available for recruitment into power-weaving. Using Ellison's figures, Jewkes shows that there was a rapid increase in the labour engaged in power-weaving between 1850 and 1878, more rapid than the increase in spinning labour, and he advances a number of arguments to indicate that the increase in weaving at this time was mainly in what he described as 'North Lancashire', that is, East Lancashire and Rossendale. Spinning was fixed in South-east Lancashire, there was a demand for weavers, and

[1] J. Jewkes, 'The Localisation of the Cotton Industry', *Economic History*, vol. II (1930), p. 96.

[2] I have calculated the proportions for 1913, 1929, and 1936 from *Worrall's Directory* in the same manner as Jewkes did for 1884 and 1928. South-east Lancashire corresponds to his southern area, East Lancashire and Rossendale to his northern area.

[3] These have been quoted above in Chapter II.

[4] Jewkes, op. cit., p. 95.

the only area in Lancashire having the suitable physical resources and textile experience where this could be met was among the hand-loom weavers of Rossendale and East Lancashire. Thus rooted in historical circumstances, the separate distribution has persisted and has indeed become more accentuated.

The location of bleaching, printing, and dyeing, is almost equally specialized. There are two factors determining their distribution. Great quantities of water are used by these processes, and water is for them in the nature of a raw material. By far the greater part of the bleach, dye, and print works, have a stream-side situation and possess water rights by which they can draw water from the streams. A few, however, now use water supplied by the urban water authorities or supplement their own resources in this way. This water must be soft. Hence the localization on streams coming from Millstone Grit or Coal Measures and consisting mainly of surface drainage. Relatively few bleachers, dyers, or printers, are in the towns: it is a 'country' industry. The second factor, important as these are finishing processes, is the desirability of contacts with the finished cloth market in Manchester. Most finishing, in fact, is done on commission. Although bleach-works and dye-works are scattered in Rossendale and East Lancashire, as well as in South-east Lancashire, many are in South-east Lancashire along the stream-side between the outer ring of towns formed by Bolton–Bury–Rochdale–Oldham–Ashton–Stockport, and the inner commercial focus of Manchester.

The concentration of merchanting in Manchester hardly requires explanation. The geographical nodality of Manchester for South-east Lancashire, North-east Cheshire, and Southern Rossendale, is complete. If any one centre is to serve as 'cottonopolis' it is Manchester. The marketing of the finished pieces of woollens and of fustians, long before the rise of the cotton manufacture, was in the hands of Manchester men. The larger Manchester houses, such as the Chethams, had one part of their establishment in Manchester and the other in London; this was for the home trade. In the latter part of the eighteenth century a foreign community of exporting merchants began to settle in the town,[1] and this grew enormously in the nineteenth century when the export of cottons developed great bulk and wide range. Its members were a common sight in the streets of Manchester. The merchanting of pieces from Manchester, developed thus early, persisted when cotton replaced wool and fustian. During the early nineteenth century the import of raw cotton was transferred to Liverpool, but Manchester retained the merchanting. Liverpool was in closer touch with the raw cotton producers, but Manchester was in closer touch with the manufacturers.

Specialization of production does not cease with limitation to a

[1] G. W. Daniels, *The Early English Cotton Industry* (1920), p. 60.

particular process, for spinners usually concentrate on a comparatively small range of counts and weavers on particular types of cloth. These further specializations have also developed on regional lines for reasons, no doubt, of economic convenience, the availability of labour with special skills, the association of like with like. Among spinning-mills there is the well-known distinction between the Bolton fine spinners and the Oldham coarse and medium spinners. The Bolton fine-spinning district includes Bolton, Leigh, Stockport, and Manchester; the Oldham coarse-spinning district, Oldham, Rochdale, and Bury. The one uses Egyptian or Egyptian-type[1] and the longer-stapled American raw cotton and spins mainly on the mule, though there is a not inconsiderable group of Egyptian and Egyptian-type ring spinners; the other uses the shorter-stapled American and Indian raw cotton and spins to a larger extent than the Egyptian section on ring spindles, though there are more mules than ring spindles in the American section. Ring-spinning in Lancashire is mainly a woman's, but mule-spinning a man's occupation. Mule- and ring-spinning have each been governed by entirely separate Wage Lists, and in mule-spinning the Oldham spinners, of coarse and medium counts,[2] and the Bolton spinners of fine counts have been paid on separate Lists, the Oldham and Bolton Lists respectively.[3] The principles of payment on these two Lists differed and their effects on the adoption of technical improvements and on differential regional competition varied. The advantages which the Oldham List offered to the employer to increase speed of working and to increase length of mule are one factor, so Prof. Jewkes and Mr. Gray argue, which favoured the great expansion in spinning in Oldham up to the close of the 1914–18 War and the decline in spinning in Preston and Blackburn, whose workers were paid on other Lists.[4] If this purely economic factor operated as is thus suggested, it helped to increase the concentration of spinning into South-east Lancashire. The relative proportions of fine and of coarse-medium spinning are indicated by the spindleage returns of the International Federation of Master Cotton Spinners' and Manufacturers' Associations. Out of a total of 41·4 million spinning spindles in the half-year ending 31 July 1936, 17·0 million of these were in the Egyptian (the fine) section, a proportion of 41 per cent.[5] The proportion of spindles in

[1] Egyptian-type raw cotton includes also Soudan, Sea Island, Metafifi, North Brazilian, Pima, and Arizona.

[2] The count of cotton yarns is the number of hanks of 840 yards length which weigh 1 lb.

[3] For a full discussion of spinning wage lists and their effects, see J. Jewkes and E. M. Gray, *Wages and Labour in the Lancashire Cotton Spinning Industry* (1935).

[4] Jewkes and Gray, op. cit., pp. 114–15. If the number of spindles in 1882 in each district be taken as 100, the number in 1925 was 217 in Oldham, 92 in Preston, and 85 in Blackburn. Structure of wage rates has since changed and regional variations have been eliminated.

[5] From various sources of evidence it was possible to classify cotton-spinning spindles in 1936 very approximately as follows: Egyptian mule, 13·75 million; Egyptian ring, 3·25 million; American mule, 16·5 million; American ring, 7·75

the towel weaving of Heywood, the coloured goods of Radcliffe, and the quilt weaving of the Bolton district.

A weaving firm is usually smaller in size[1] than a spinning firm, for reasons explained by Prof. S. J. Chapman in 1904. The fundamental unit in a weaving shed is four to eight looms, and a loom-shop employing electric power may be run by a couple of partners. But in a spinning-mill the fundamental unit consists of the preparatory machinery such as carding engines with the appropriate number of spinning-frames to keep them fully occupied. The winding and warping preparatory to weaving may be done on commission and need not be performed in weaving sheds. A weaving shed is usually larger in size in the Blackburn than in the Nelson-Colne group, and it is smallest of all in the Colne coloured goods trade. In the Burnley, Nelson, and Colne districts, several firms are frequently housed in the same shed owned by a room and power company, to whom they pay rent. Many large firms of the present day began in a room and power shed and moved to larger premises later. In Nelson as many as 45 per cent of all the looms in the district in 1936 were in sheds of this kind.

IV

THE EXPORT TRADE

The cotton industry must be studied not only in relation to the local environment, which provides the suitable physical and economic conditions for its practice, but also in relation to the world environment from which it draws all its raw material and to which it exports a big proportion of its production, larger until recent years than any other British industry. This world environment has had a profound influence on its volume and character.

The proportion of the total production that is taken by the home and by the export markets respectively is not easy to calculate, and it differs according to the method of calculation employed.

TABLE LXXIII

Percentage of Cotton Production Exported

In percentages	1907	1912	1924	1930	1933	1935
Yarn *in lb.*	15·2	13·4	11·7	13·1	11·4	11·5
Piece goods:						
in linear yards .	88·9	85·9	83·2	80·4	66·5	65·3
in square yards .	—	—	74·4	72·5	58·0	57·6
in cwt.	—	—	71·2	63·7	49·4	49·6

[1] The *Report* on the 1935 Census of Production shows that 'establishments' employing under 200 persons were 56 per cent of all spinning 'establishments', but 74 per cent of all weaving 'establishments'.

The proportions exported of yarn production and of piece goods production, as calculated by the Censuses of Production for 1907, 1912, 1924, 1930, and 1935, are set out in Table LXXIII.[1] It is clear that the proportion of piece goods exported differs considerably according to whether it be calculated in linear yardage, square yardage, or weight. On the basis of weight and combining both yarn and piece goods, the proportion of production exported was 74·6 per cent in 1924, 68·5 per cent in 1930, and 55·2 per cent in 1933. By a calculation for the early inter-war years of output and export in terms of yarn, Profs. Daniels and Jewkes arrived at comparable results. Their estimate for 1924 was 70 per cent and for 1913 74 per cent.[2] The conclusion is therefore that before the 1914–18 War, and in the early years of the inter-war period, export was approximately three-quarters of production. Since then the percentage fell, and it stood at just over half the total production in 1935. Deliveries to the home *civilian* market were comparable to deliveries to export in 1950, according to the returns of the Cotton Board.

TABLE LXXIV

Production, Export, Import, and Home Consumption of Cotton Piece Goods

In mill. linear yards	Production	Export	Production less export	Import	Available for home consumption
1907	7,088	6,298	790	65	855
1912	8,044	6,913	1,131	98	1,229
1924	5,590	4,649	941	31	972
1930	3,179	2,530	649	70	719
1933	3,183	2,117	1,066	18	1,084
1935	3,081	2,013	1,068	22	1,080

The export trade can be measured, more continuously than production and for a longer term of years, from the *Annual Statement of Trade*. Fig. 64 gives the volume of exports, year by year, of cotton piece goods in linear yards, that is, in quantities and not in values. It is necessary for the present purpose only to consider the most recent fluctuations. The export of piece goods continued to increase up to the eve of the 1914–18 War, and it reached its maximum in 1913. During the first post-war decade (1920–9) it fell to a level of 67 per cent below the 1904–13 pre-war decade (59 per cent below the 1913 level), and during the Great Depression, which began at the close of 1929, it fell for the five years 1930–4 to an even lower level of 35 per cent below the 1904–13 level (30 per cent below the 1913 level).

[1] The returns for 1933 are from the *Report* of the Import Duties Act Enquiry for that year.

[2] G. W. Daniels and J. Jewkes, 'The Comparative Position of the Lancashire Cotton Industry and Trade', *Trans. Manchester Statistical Society* (1926-7), p. 63.

It did not subsequently recover; it fell to even lower levels in 1938–9, and lower still in the late War. The export of cotton piece goods has thus been peculiarly subject to world dislocations: it fell during the 1914–18 War, it fell again during the Great Depression, and it fell still further with the uncertain situation of 1938–9. On each occasion it has been unable to recover its previous level. Although export increased after 1945, it still failed to reach the 1938–9 level. The reactions of this on the volume of cotton production in the country have been profound, and will be discussed later. The export of yarn reached its maximum in the 'eighties of the nineteenth century, and it has declined each decade since that time, but at a slower rate than the decline of piece goods export.

Piece goods are exported in various forms—grey unbleached, white bleached, printed, dyed in the piece, and coloured cottons woven from dyed yarn. They vary in value in that order, the grey unbleached being the lowest and the dyed the highest in average price (see Table LXXV). The quantities of each of these classes exported in 1913, 1929, 1935, and 1950, as examples of the levels previously distinguished, are set out in Table LXXV, together with the proportion that each class bore to the total for that year.

TABLE LXXV

Export of Cotton Piece Goods by Classes

	Value per thousand linear yards £	1913		1929		1935		1950	
		Mill. linear yards	Per cent	Mill. linear yards	Per cent	Mill. linear yards	Per cent	Mill. linear yards	Per cent
Grey . .	14·5	2,357·4	33·3	954·8	25·4	323·2	16·1	42·8	5·2
Bleached .	17·1	2,045·5	28·9	1,288·3	34·2	589 2	29·3	191 3	23·5
Printed .	21·0	1,230·9	17·4	551·7	14·7	455·2	22 6	320·7	39·3
Dyed in piece	23·5	1,151·4	16·3	825·7	21·9	535·0	26·6	206·0	25·3
Dyed in yarn	23·9	290·5	4·1	144·3	3·9	111·1	5·5	54·6	6·7
Total .	19·6	7,075·6	100 0	3,764·9	100 0	2,013·7	100·0	815·3	100·0

It is clear that the relative proportions of the several classes changed very considerably. The proportion taken by grey unbleached goods, the cheapest of all, fell consistently from one-third in 1913 to one-twentieth in 1950. This change in the proportion taken by grey goods was already in progress before 1913, as Fig. 64 shows. The export of all classes greatly declined, but the decline was greatest in the cheaper grey goods and least in the dyed goods with the highest average value per yard. There was the same sort of change in the yarn trade, the export of 40's counts and under taking up a

progressively smaller share of the total yarn exported. This differential decline meant that the depression in the American section of the industry was more severe than the depression in the Egyptian section.

The export of piece goods is world-wide. It was gradually built up on the basis of the world-wide distribution of British shipping services and of Free Trade, under the influence of which Britain became so very largely an exporter of manufactures and an importer of foods and raw material. Table LXXVI shows the proportions of the total British piece goods export taken by each of the continents and by the Empire, and its constituent parts, for each of the years

Fig. 64

EXPORT OF COTTON PIECE GOODS FROM THE UNITED KINGDOM, 1851–1939

1913, 1929, 1935, and 1950. The world-wide distribution is clear. The trade with Asia, which had been two-thirds of the total in 1913, has fallen away and in both 1935 and 1950 was little more than a quarter of the whole. The proportion of the total trade taken by the other continents had risen with the decline of the trade with Asia, although in actual quantities the trade with each continent also fell. The most stable markets of all are in the Dominions and in the Crown Colonies, and here one or two areas, notably the Union of South Africa and British West Africa, actually took greater quantities of cotton piece goods in 1935 than they did in 1913. Together the Dominions and the Crown Colonies in 1950 took two-thirds of total exports. The fall in total export of piece goods to Asia has been due, apart from Indian fiscal autonomy and ultimate independence, partly to the development of cotton industries in India and China, in 1913 the two largest individual markets, and partly to the growth of the export of cotton goods from Japan. The influence of these alternative supplies will be clear from the following figures. In 1913 India, China, and Japan, had 9·3 million spinning spindles, to take one

TABLE LXXVI

Distribution of Cotton Piece Goods Export

	In percentages of total export of each year			
	1913	1929	1935	1950
Europe	7·3	11·9	14·9	9·1
Asia	66·5	50·9	22·7	21·2
Africa	10·0	15·7	21·9	36·6
Americas	12·7	15·2	25·9	8·7
Australasia	3·0	5·6	14·1	20·5
British Empire	56·4	53·2	58·4	78·1
Dominions	5·5	8·4	29·5	33·6
India	43·2	33·9	12·5	11·4
Crown Colonies	7·7	10·9	16·4	33·1

In order to obtain comparability between the years, Eire has been omitted from 1929, 1935 and 1950; the Dominions have been defined as including Canada, Union of South Africa, Australia and New Zealand; and India as including Burma but excluding Ceylon. The Anglo-Egyptian Sudan was included with Egypt in the returns for 1913.

index of the size of their factory cotton industries, while in 1936 they had 25·6 million; or, to take an index of actual manufacturing activity, mills in 1912–13 in India, China, and Japan, consumed 4·4 million bales of raw cotton and in 1935–6 9·0 million bales. These figures take no account of domestic as distinct from factory manufacture: this was, however, much smaller in volume in spinning than in weaving. Export from Japan dealt a further blow at British trade to Asia, already undermined by home factory production in India and China. The decline has been greatest of all in the Far East, where Japanese competition has been most intense; it has been less in India (although British cotton exports to India were in 1935 less than one-fifth of what they had been in 1913), and less again in West Asia, although here there has been Italian competition as well as Japanese. It was to these very markets that the bulk of the cheapest goods—the grey unbleached—had gone, and it is the export of grey cloths that has declined most. In 1913, of India's cotton import from Britain, 48·5 per cent was of greys, but in 1935 only 20·0 per cent, and in 1950 less than 1 per cent. The reasons for the effective competition of Japan with Britain in the cotton markets of the world (for Japanese competition has been felt in Africa, Australia, and South America, as well as Asia) are dealt with fully in the references listed below.[1] Among them are wage costs as a percentage of total costs, about half

[1] G. E. Hubbard, *Eastern Industrialisation and its Effect on the West* (1935); B. and H. Ellinger, 'Japanese Competition in the Cotton Trade', *Journal Royal Statistical Society*, vol. XCIII (1930); A. Pearse, *Report on the Cotton Industry of Japan and China* (1930); G. C. Allen, *Japanese Industry* (1939).

the level of what they were in Britain, the continuous working of machinery by means of two shifts per day, the employment of ring spindles and of automatic looms, and, although opinion is not so unanimous on this point, perhaps a more suitable economic organization of the industry. 'Roughly speaking,' it has been declared, 'two-thirds of . . . export losses were due to development by . . . former customers of their own industries, and one-third was captured by Japan.[1] Nevertheless, despite the absence of Japanese competition since the war, Lancashire's export has not recovered.

V

THE EFFECTS OF DECLINE IN EXPORT

The decline in the export markets outlined above had profound repercussions on the British cotton industry. The home trade fluctuated from year to year, but there was no pronounced downward trend during the inter-war period. It was the contraction of the export trade that was then mainly responsible for the decline in output. For convenience of comparison, the same returns as are set out in Table LXXIII have been calculated in Table LXXVII as percentages of the 1912 level. In comparing the percentages for the

TABLE LXXVII

Production of Cotton Goods, 1912–37

(As percentage of 1912 level)

	1912	1924	1930	1935	1937	1950
Output of yarn in lb. . . .	100	70·4	52·8	61·9	68·5	43·0
Output of piece goods in linear yards .	100	69·5	39·5	38·6	48·4*	26·7
Mill consumption of raw cotton in lb.	100	68·4	51·8	58·3	65·1	

The raw cotton years used for mill consumption of raw cotton are 1912–13; 1923–4, and 1924–5; 1929–30 and 1930–1. The 1935 figure has been calculated from the 1935 Census of Production and the 1937 figure from that given in the Working Party Report (p. 22). No figure available for 1950.

* Estimated, for only square yardage returns are available for 1937 in the Appendix of the *Report* of the Cotton Board Committee to Enquire into Post-war Problems (1944).

several years given it must be remembered that the years do not each occupy identical places in cyclical fluctuations. The production of cloth has declined relatively more than the production of yarn; in other words, the depression in the weaving section during the inter-war years was more acute than in the spinning section. Output fell to very low levels during the 1939–45 war: it grew after the war but even in 1950, the best of the post-war years, it was still far below the level of 1937.

[1] *Cotton*, Working Party Reports (1946), p. 5.

For reasons which will be already clear, the shrinkage in production has been greatest at the coarser end of the trade and least at the finer end. The Census of Production returns do not give any help in measuring the relative decline of the two sections. It may be stated, however, that in general terms the American section experienced depression immediately after the boom of 1919–20, and that the Egyptian section did not experience depression until after 1929. Profs. Daniels and Jewkes show graphs of employment month by month in the 1920–7 period in Oldham and in Blackburn–Accrington–Darwen, representing the coarser end of spinning and weaving respectively, and in Bolton–Leigh and Colne–Nelson–Burnley, representing the finer end of spinning and weaving respectively, which bear out these differences.[1] As fine and coarse spinning and as the weaving of the cheaper and of the finer cloths have each specialized geographical distributions, this relative difference between the two sections has a marked geographical expression. The regional distribution of unemployment for a later date was discussed in *Readjustment in Lancashire*. In the first half of 1936 unemployment in the Blackburn area was 27·2 per cent, in the Burnley area 17·9 per cent, and in the Rossendale area 13·9 per cent.[2] These are sample returns only, but they display the kind of effects which developed.

The cotton industry had to face, during the inter-war period, a great shrinkage in production, relatively greater in the weaving than in the spinning section, and it had to devise means to adapt itself to the new situation. Readjustment was long delayed. During the inter-war period it was not realized until 1927–9 that the restriction in the activity of the industry was permanent. The lower level of activity in the immediate post-war period was regarded as similar in cause to one of the periodic depressions the industry had experienced before the 1914–18 War, and which would in time disappear. Adjustment to depression was made by short-time working, the traditional method in the circumstances; it was advantageous during short depressions, as it kept the personnel of the mill together, but disadvantageous in conditions of permanent contraction as it increased working expenses and hindered the mobility of labour. It is true that analyses of the position such as those by Profs. Daniels and Jewkes[3] drew the distinction between the pre-war depressions within an expanding market and the post-war depression due to intense foreign competition within, it may be added, a contracting total of international trade, but it was not until the even lower level of activity after 1929 was reached that the permanence of the contraction became universally recognized. Readjustment was delayed

[1] Daniels and Jewkes, *Trans. Manchester Statistical Society* (1927).

[2] *Readjustment in Lancashire* (1936), p. 71.

[3] Daniels and Jewkes, *Trans. Manchester Statistical Society* (1926–7); *Economic Journal*, vol. XXXVII (1927); *Journal Royal Statistical Society*, vol. XCI (1928).

not only by failure to realize its permanence, but also by the financial reconstitution of the industry in 1919–20. According to H. Campion's investigations, quoted by Daniels and Jewkes, it involved 46 per cent of the total number of spindles and 14 per cent of the total number of looms, the looms being mostly those in the possession of combined firms practising spinning as well as weaving, and the spindles in 'reconstituted' firms involving a rather greater proportion of the American than of the Egyptian section.[1]

The readjustment of the industry to this declining demand during the inter-war period took several forms:

(*a*) The reduction of spindleage and loomage.
(*b*) The technical improvement of the industry.
(*c*) Changes in economic structure.
(*d*) Changes in sources of raw cotton supply.
(*e*) The development of new fabrics and the use of other materials.

Many, but not all, of these forms of readjustment have ascertainable distributional effects.

For reasons indicated above there was no real diminution of plant until after 1927. Since then decline has been continuous. Table LXXVIII and Fig. 65 set out the evidence. According to the annual returns of *Worrall's Directory*, the number of spindles (including doubling spindles) in 1936 was 75 per cent of the number in 1929. The returns of the International Federation of Master Cotton Spinners' and Manufacturers' Associations show for the half-year ending 31 July 1936, spinning spindles as 74 per cent of the number in the half-year ending 31 July 1929. The two sources agree. The number of spindles had, therefore, by 1936 shrunk to three-quarters of their number in 1929. The decline was unequal in the two sections of the spinning trade. The number of spinning spindles in the half-year ending July 1936, in the Egyptian section, was 97 per cent of the number in 1929, but in the American section, 63 per cent. If 1949 be compared with 1937, however, there has been little decline in the production of the coarsest counts, under 20's, though it is still true that the production of fine counts has declined less than the production of medium counts. The Egyptian and the American sections have, as has been shown previously, each a fairly well-defined geographical distribution, so that the greater relative decline of the American section is concentrated into particular areas. It is possible to measure this statistically by means of the district returns of *Worrall's Directory*.

At Oldham, the centre of coarse and medium spinning, the number of spindles in 1936 was 66 per cent of their number in 1929, but the

[1] Daniels and Jewkes, *Journal Royal Statistical Society*, vol. XCI (1928), pp. 167–82. A fear of a revival of a similar financial 'boom' exercised the industry in 1946.

TABLE LXXVIII

Output, Employment, and Plant in the Cotton Industry, 1912–50

	1912	1924	1930	1935	1937	1937 as per cent of 1912	1950
Output of cotton yarn in U.K. in million lb.	1,983	1,395	1,047	1,225	1,234	68·5	853
Per cent in Lancashire on net values	—	84	83	80	—	—	—
Output of cotton piece goods in U.K. in million linear yards	8,050	5,590	3,100	3,081	3,640	43·4	2,123
Per cent in Lancashire on net values	—	88	89	84	—	—	—
Numbers in cotton spinning in U.K. in thousands	622	253	191	182	176	—	107
Numbers in cotton weaving in U.K. in thousands		275	189	167	187*	—	137*
Spinning plant in U.K. in million spindles, mule equivalent	61	63	63	48	44	72·1	34
Weaving plant in U.K. in thousand looms	786	792	700	530	505	64·2	390*

Output and employment returns for 1912–35 from the *Reports* on the Censuses of Production and for 1937 and 1950 from the Cotton Board. Plant returns from the *Reports* of the Cotton Board.

Numbers employed in 1924 and 1930 include those in Northern Ireland. Numbers employed in weaving in 1937 include those on rayon weaving.

Mule equivalents are as follows: mule spindles, 1; ring spindles, 1½.

* Including those in rayon weaving.

decline was masked here to some extent by the conversion of some mills to fine spinning. The group of towns comprising Ashton-under-Lyne, Dukinfield, Stalybridge, and Mossley, had suffered a greater decline than Oldham, to 57 per cent of the spindles they had in 1929. At Bolton and Leigh, centres of fine spinning, the decline between 1929 and 1936 was only to 95 per cent and to 98 per cent respectively of the level of 1929. This readjustment in the physical plant of the industry took place prior to the operation of the Scheme for Dealing with Surplus Capacity which began to receive offers of spindles for sale or for sealing in 1935. By the end of the third year of operation of the Spindles Board (13 September 1939), 6,174,000 mule-equivalent spindles had been acquired or were about to be acquired. But the actual scrapping of plant lagged behind the need. Even during the relative boom year of 1937 there was an unused spindle capacity of 9·2 per cent, and on the eve of the late war it had risen to 29·3 per cent.[1] The estimates of post-war spindleage requirements made by the Cotton Board Committee to Enquire into

[1] The percentage of 9·2 was for the six months ending 14 September 1937, and of 29·3 for the six months ending 14 March 1939. These returns are from the *Third Annual Report* of the Spindles Board, Cmd. 6157 (1940).

Post-war Problems range between the limits of twenty-four and forty million mule-equivalent spindles.

The shrinkage in the total number of looms had been relatively greater than in the total number of spindles, for the surplus was greater. According to *Worrall's Directory* the number of looms in Lancashire in 1936 was 69 per cent of the number in 1929, while the number of spindles was 75 per cent of the level of 1929. The number of looms had, therefore, shrunk to little more than two-thirds of their number in 1929. In general terms it can be said nevertheless, that the rate of decline *in relation to surplus capacity* had been less in the case of looms than of spindles. The decline had been unequal in the two sections of the weaving trade. It had been greater in the weaving of the coarser cloths and less in the weaving of the finer cloths, for it was in the coarser grey goods that the decline in exports had been most pronounced. The number of looms in Blackburn, Accrington, and Darwen, centres of the weaving of the cheaper cloths, in 1936 was 57 per cent of the 1929 level, but the number of looms in Burnley, Nelson, and Colne, centres of the weaving of the finer cloths, was 75 per cent. These calculations have been made, as for spindleage, from the district returns of *Worrall's Directory*. The geographical expression of differential decline is as clear in the weaving as in the spinning branch of the industry. There was no scheme in operation before the late war to regulate the elimination of surplus looms. The estimates of post-war loom requirements made by the Cotton Board Committee range between 273,000 and 429,000 looms, these levels being determined so as to be in proportion to the spindleage capacity.[1] The looms weaving rayon fabrics will presumably be in addition to these.

The second set of changes refers to the technical improvement of the processes of manufacture, particularly of those which lessen the cost of production. In general, it may be stated that there has been very little re-equipment or replacement of plant in the industry since the close of the 1914–18 War owing to lack of capital. Re-equipment in the Lancashire cotton industry, as has been shown by J. Ryan[2] from the evidence of a large sample of spindles (20 million) and a smaller sample of looms (50,000), has been largely confined to boom periods. If the normal effective life of spinning frames and looms be taken as about thirty years, then in this sample 36·7 per cent of the mule spindles, 24·0 per cent of the ring spindles, and 41·7 per cent of the looms, with varying proportions of other machinery, were set up before 1900, and so were over thirty years old in 1930, the date of

[1] See also *Proc. Textile Institute* (1938), pp. 438–9. Home market demand was there estimated at 1,800 to 1,900 million square yards and export market demand at 1,700 million square yards, which together would require 380,000 looms working full time.

[2] J. Ryan, 'Machinery Replacement in the Cotton Trade', *Economic Journal*, vol. XL (1930).

these investigations. If well cared for, machines can, however, work satisfactorily for longer than thirty years. The main technical developments in cotton manufacture are ring spinning, high-draft spinning, high-speed winding, and automatic or semi-automatic looms. It is necessary now to examine briefly the extent to which these have been adopted.

British cotton spinning has been based mainly on the mule, which is particularly valuable in the spinning of the finer counts, but which

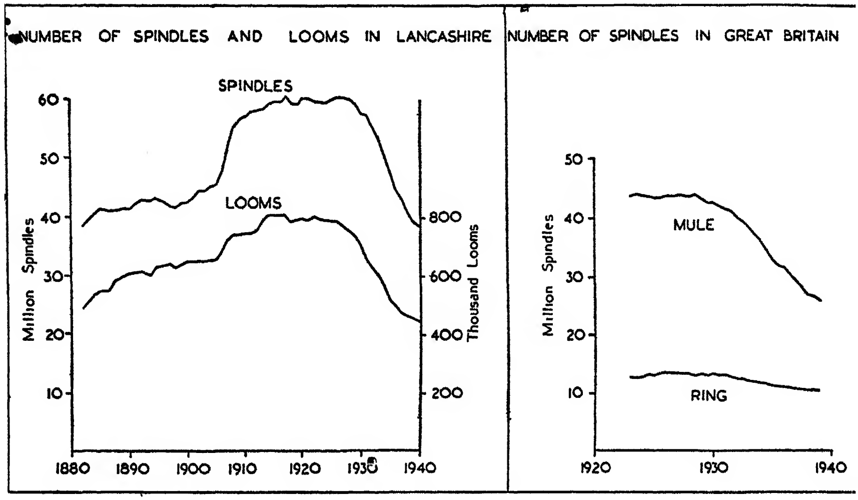

Fig. 65

NUMBER OF COTTON SPINDLES AND LOOMS IN LANCASHIRE AND OF MULE AND RING COTTON SPINDLES IN GREAT BRITAIN

Left-hand diagram redrawn from *Worrall's Directory*. Right-hand diagram constructed from the returns of the International Federation of Master Cotton Spinners' and Manufacturers Associations and of the Cotton Board. The number of spindles is the sum of spindles and is not in mule equivalents. By 1950 the number of spindles had fallen to 29 million (19 mule, 10 ring) or 34.5 million mule equivalent. Practically the whole of the decline was in mule spindles. The number of looms in place (including those in rayon) in running mills in 1950 was 382,000.

has two specific disadvantages. It has a lower level of production per spindle than the ring frame owing to its fundamental mechanical principles, for it is an intermittent spinner whereas the ring frame is a continuous spinner; and it has a higher cost of production as, with British practice, the labour employed on it is almost wholly male, whereas ring spinning is a woman's job. In every other cotton industry in the world ring spindles greatly outnumber mule spindles. Fig. 65 shows the number of mule and ring spindles in Britain, according to the returns of the International Federation for each half-year from 1923 to 1936. The number of mule spindles was steady up to 1929, but it has since declined, the number in the

half-year ending July 1936 being 71 per cent of the number in the corresponding half-year of 1929. The number of ring spindles increased slightly in the early inter-war years, but declined during the Great Depression, the number in 1936 being 83 per cent of the number in 1929. The returns of the Spindles Board show that between the half-year ending 14 September 1936 and that ending 14 March 1939 mule spindles decreased by 14·2 per cent, but ring spindles by only 4·6 per cent. Ring spindles have thus increased relatively, but not actually, and it is certain that there is hardly any replacement of mule by ring spindles. The one has merely had a greater survival capacity than the other. According to some returns of the production of mule twist and ring twist yarns quoted by Prof. Jewkes and E. M. Gray in 1935, the share of the total production from ring spindles was then greater than that from mule spindles despite the fact that mule spindles were the more numerous.[1] Ring spinning in 1936 was most prominent relative to mule spinning in Rochdale, Stockport, Wigan, and Blackburn. The primary spinning towns are dominated by the mule. High-draft spinning and high-speed winding and warping, both of which eliminate labour to some degree and so cheapen the cost of production, had not, during the inter-war period, been adopted in Britain to any large extent.[2] The results to be expected from a large-scale introduction of high-draft spinning are discussed by the *Report* of the Platt Mission[3] and by the Report of the Board of Trade Working Party.[4] There is at the present day, and will probably continue to be in the future, marked incentives to the adoption of high-draft spinning in British mills (provided the capital costs can be met) because of the shortage of labour and because of high wage-rates.[5] Earnings of cotton operatives were at a very low level during the inter-war period relative to other occupations and they frequently provided a living wage only because of the peculiar economic structure of the family in Lancashire cotton towns, the wife working as well as the husband and having few children to look after.

The changes in weaving were of two kinds. There is the system

[1] Jewkes and Gray, op. cit., pp. 193–4.

[2] See *An Industrial Survey of the Lancashire Area* (1932), pp. 132–7, 319–21.

[3] *Report* of the Cotton Textile Mission to the United States of America, Ministry of Production (1944). The issues involved are very complicated in detail and present innumerable pitfalls, but certain general statements can be made. 'A re-equipped mill on high draft could produce a little more cheaply, even on single shift, than a mill operating as at present. On double shifts the saving is increased to about 10 per cent of the present conversion cost.' The huge differences which the Platt Mission discovered between British and American practice referred to production per man-hour and not to cost of yarn production. Moreover, not the whole of these differences are attributable to high-draft spinning; they are due also to greater standardization of product in long runs in American mills.

[4] Appendix II, p. 253.

[5] See *Report* of the Evershed Commission on wage-rates in cotton spinning, Ministry of Labour and National Service (1944).

known as 'more looms to a weaver' which involves only minor changes in loom attachments, but a radical reorganization of the labour in the weaving shed and there is, secondly, the automatic or semi-automatic loom which involves radical or considerable changes in equipment and the same radical reorganization of labour in the shed. The second, because it involves capital outlay, has been adopted to only a small extent. Ryan estimated that in 1930 automatic and semi-automatic looms involved less than 3 per cent of the loomage then existing. The Platt Mission *Report* estimated the proportion at no more than 5 per cent in 1944.[1] The Costs Sub-Committee of the Board of Trade Working Party found that, while automatic loom working was cheaper than four looms to a weaver, it depended on the type of cloth being woven whether it was cheaper than eight looms to a weaver. The 'more looms to a weaver' system has been adopted on a much wider scale. In evidence before the Board which was appointed to examine an application for an order on cotton weaving wages in the summer of 1935, it was estimated that 15 per cent of the total looms were then working on the six-loom system, 1 per cent on more than six looms, and the rest on four or fewer looms per weaver, the customary number.[2] The evidence of cost of working reviewed in *An Industrial Survey of the Lancashire Area* points to a saving in weaving wages of 20–30 per cent and in total cost of cloth of 2–7 per cent under the eight-loom system. The output per weaver is increased by approximately 40 per cent on the six-loom system and by approximately 84 per cent on the eight-loom system, but the production per loom is slightly decreased owing to slower loom speeds and the saving in weavers' wages is considerably offset in order to pay labour for oiling, sweeping, cloth and weft carrying, jobs formerly undertaken by the weaver himself. The number of looms per weaver was greater in the weaving than in the spinning district, and within the weaving district it was greater in the Burnley-Nelson-Colne district than in the Blackburn district. The 'more looms to a weaver' system had a geographical expression.[3]

The third set of changes refers to economic structure. The Lancashire cotton industry has been organized on essentially horizontal lines, and this was probably suited to conditions of Free Trade and an expanding market in the nineteenth century. But many

[1] The Working Party recommended a large increase in the number of automatic looms. The problems involved in the provision of these are discussed in the Report of a Committee which reported in June 1947.

[2] *Report* to the Minister of Labour (1935), Cotton Manufacturing Industry (Temporary Provisions) Act, 1934, p. 7.

[3] *An Industrial Survey of the Lancashire Area* (1932), pp. 137–47, 324–32. The Platt Mission and the Costs Sub-committee of the Board of Trade Working Party have presented a great deal of further evidence. A recent extensive experiment in redeployment has displayed large increases in production per man hour (89 per cent), and in earnings (43 per cent) but in costs only 22 per cent. *Report of Cotton Manufacturing Commission* (1949) (Chairman R. M. Hughes). See also *Productivity Team Report on Cotton Weaving* (1950); L. H. C. Tippett, *J. Royal Statistical Society*, vol. cx (1947).

competitive industries abroad, notably the Japanese, have developed a vertical organization and the size of firm, moreover, is considerably larger than in Britain. The American industry also has a vertical structure. Amalgamations and experiments in vertical organization seemed natural to the Lancashire industry faced with a shrinkage of markets, and they were pressed on it by the Banks, and recently by the Working Party, on the grounds of economies that it was claimed would result. Amalgamation has gone relatively far in spinning, from the first organized in relatively large units, and four large amalgamations control nearly a third of the total number of spindles. Only one of these, however—the Lancashire Cotton Corporation—is an organic amalgamation in which production and sales are in the hands of a single management. The Lancashire Cotton Corporation was formed in 1929 as a vertical organization with looms as well as spindles, and it intended to weave as well as to spin. It acquired mills and sheds, mostly those in the hands of the Banks, scattered all over Lancashire, but it has since abandoned its looms and is now entirely a spinning concern. Apart from two mills, all its premises are now in the spinning district and within the spinning district two-thirds are in the neighbourhood of Oldham, Stockport, and Ashton-under-Lyne. These premises mostly spin coarse and medium counts and exhibit a very small range of size, each having just above or just below 100,000 spindles. There have been no successful attempts at large-scale amalgamation in the weaving branch of the industry, and weaving, as has been indicated earlier, has always been an industry of relatively small firms. During the early years of the late war British Overseas Cottons Ltd. was set up as a means whereby co-operation between spinners, manufacturers, finishers, and merchants, could be secured for standardized production to fulfil specific bulk orders. This kind of machinery achieves some of the objects of a vertical organization while avoiding the rigidity which is one of its disadvantages. It may be laid down that a combined mill can achieve complete balance of its separate departments only if it adheres rigidly to a standard product: this is the practice in the horizontally organized American industry.

The fourth set of changes refers to the raw cotton supply. Cotton forms the largest single element in the cost of production. It varies, of course, according to the type of cotton; it varies, also, according to the counts spun, being relatively high for the low counts and relatively low for the fine counts; and it varies according to the kind of cloth woven. From spinning costings of particular firms Prof. Jewkes and E. M. Gray came to the conclusion that raw cotton accounted during the inter-war period for one-half to three-quarters of the total cost of yarn,[1] and from weaving costings of particular firms given in an appendix to *An Industrial Survey of the Lancashire*

[1] Jewkes and Gray, op. cit., p. 37.

Area it can be calculated that yarn then accounted for three-quarters of the total cost of the finished cloth where that was of a standard variety.[1] It has recently been calculated that on standard practice of low-draft spinning and four looms to a weaver with wages at the level of 1945–6 (considerably higher than wages during the inter-war period, to which the above refer), of the total cost of making drills raw cotton contributed 59 per cent and of shirtings 25 per cent.[2] The employment of cheaper qualities of raw cotton is therefore an obvious step in an industry anxious to lower its cost of production. There have been increased takings of Indian and South American cottons.[3] The quantities of American raw cotton taken by Britain in 1935–6 were little more than a third of what they had been in 1912–13. The consumption of Indian raw cotton in Lancashire, and in other countries, has varied in inverse relation to its price.[4] It was the mills spinning the lower counts which thus employed Indian cotton.

The fifth form of readjustment is the development of new fabrics and the use of materials other than cotton. During the course of its history the industry has from time to time invented new fabrics and new methods of finishing such as mercerizing, and it has developed new uses such as tyre fabrics. Readjustment to a rapidly shrinking demand requires rapid development of new fabrics and processes. This involves experiment and research, which does not always give quick returns. The employment of materials other than cotton has proceeded more rapidly. There is some spinning of rayon yarns in cotton-spinning mills, and a great deal of rayon weaving on cotton looms. Spun rayon as a percentage of yarn production increased steadily from 1·5 per cent in 1937 to 8·1 in 1950. Rayon fabrics as a percentage of cloth output have also increased steadily: together with cotton-rayon mixtures, they were 11·7 per cent in 1937 and 25·0 per cent in 1950. In both spinning and weaving, rayon is increasing actually as well as relatively. The rayon weavers are scattered throughout the entire cotton manufacturing district and there are plants in the spinning district, especially at Leigh; but they are most numerous in Colne and Nelson, Blackburn, Burnley, and Preston.

At the present day there is a restriction in level of production owing to shortage of labour, as in wool textile manufacture and as in coal mining. The shortage of labour is due principally to the remembrance of the low level of earnings during the inter-war period, and to alternative and more remunerative employment in other industries.

[1] *An Industrial Survey of the Lancashire Area* (1932), pp. 324–8.

[2] Percentages calculated from table on p. 254 of the Report of the Board of Trade Working Party.

[3] In 1946 as compared with 1939 there was a decline in the percentage of Indian and Peruvian but an increase in the percentage of Brazilian cotton.

[4] *Second Annual Report* of the Lancashire Indian Cotton Committee (1935), p. 23.

Wage rates have had to be advanced considerably and, as a result, it is no longer as essential for married women to go out to work to supplement the family income. This has reduced labour still further. The Cotton Board has a special department which is actively encouraging labour recruitment.

VI

TRENDS IN DISTRIBUTION OF MILLS WITHIN LANCASHIRE

In conclusion, I propose to consider the extent to which the geographical distribution of the industry within Lancashire is static or in process of change. I have investigated this in some detail by (*a*) a comparison of the distributions of 1913, 1929, and 1936; and (*b*) a classification into new premises, premises closed down, premises with increased and premises with decreased plant. Each of these has been mapped in detail.[1] Two of these maps have been reproduced as Figs. 66–7. The first conclusion that emerges from this investigation is that Lancashire's share of the total cotton industry of Great Britain has remained virtually unchanged. The employment returns of the Census of Production indicate some small decline in Lancashire's share, but the employment returns of the Ministry of Labour some slight increase. The second conclusion is that there has been no clearly defined contraction in the limits of the industrial area. It might have been expected that a contracting industry would withdraw its outposts and contract on to its nucleus, but there is no evidence of such contraction. The marginal factories are mostly relatively new, built during the period of expanding trade ending in 1914. Moreover, some of these marginal factories had local 'disadvantage allowances' which permitted managements to pay slightly lower wages.[2] These conditions may have had some effect in preventing the withdrawal of the outposts. Contraction has, therefore, taken the form of a lesser density of premises within the industrial region, a loosening of the industrial fabric and, in particular, of shifts in balance between different parts of the industrial region and between different types of site within it. The shifts which can be distinguished are:

(*a*) the further definition of the spinning and of the weaving districts;
(*b*) the greater differential decline of the 'coarse' than of the 'fine' districts;
(*c*) the development of differences between town and country;
(*d*) the lesser relative importance of river-side and canal-side sites.

The first and second sets of changes have already been considered earlier in this chapter.

[1] W. Smith, 'Trends in the Geographical Distribution of the Lancashire Cotton Industry', *Geography*, vol. XXVI (1941).

[2] See p. 477.

The differences which have developed between town and country are set out in Table LXXIX, in so far as they can be registered according to administrative status. If the four classes of administrative areas be regarded as falling into three groups—the county

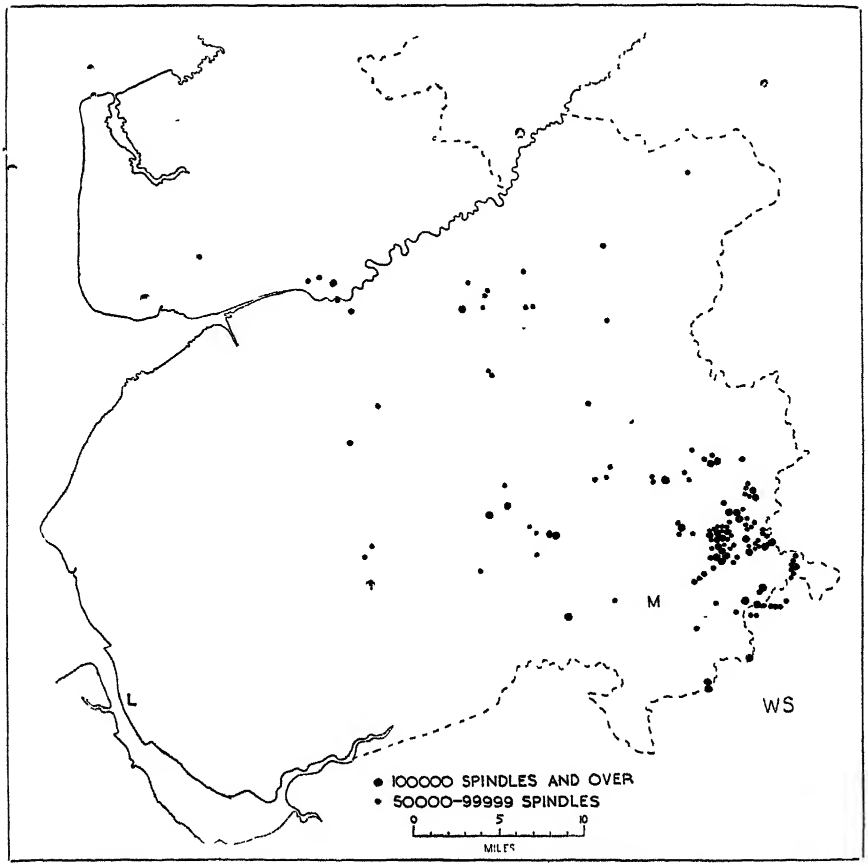

Fig. 66

DECREASED PLANT IN LANCASHIRE COTTON SPINNING MILLS, 1929–36

Spindleage is in mule equivalents (1 mule spindle = 1, 1 ring spindle = $1\frac{1}{2}$), excluding doubling spindles. Decreases of under 50,000 spindles have been omitted for the sake of clarity. The map shows decreases both in mills still running in 1936 and in mills wholly closed down at that date. L and M are on the site of the Town Halls of Liverpool and Manchester respectively. The period between 1929 and 1936 was the period of most rapid decline of spindles 'in place'.

boroughs representing the larger towns, the municipal boroughs and urban districts the smaller towns and larger villages, and the rural districts the country—then the larger towns have a larger share of the spinning than of the weaving, the smaller towns and larger villages have approximately equal shares of spinning and of weaving,

while the country has a much greater share of weaving than of spinning. Spinning is thus weighted towards the larger, weaving towards the smaller, groupings of population. This is in harmony with the greater size of spinning-mills as compared with weaving

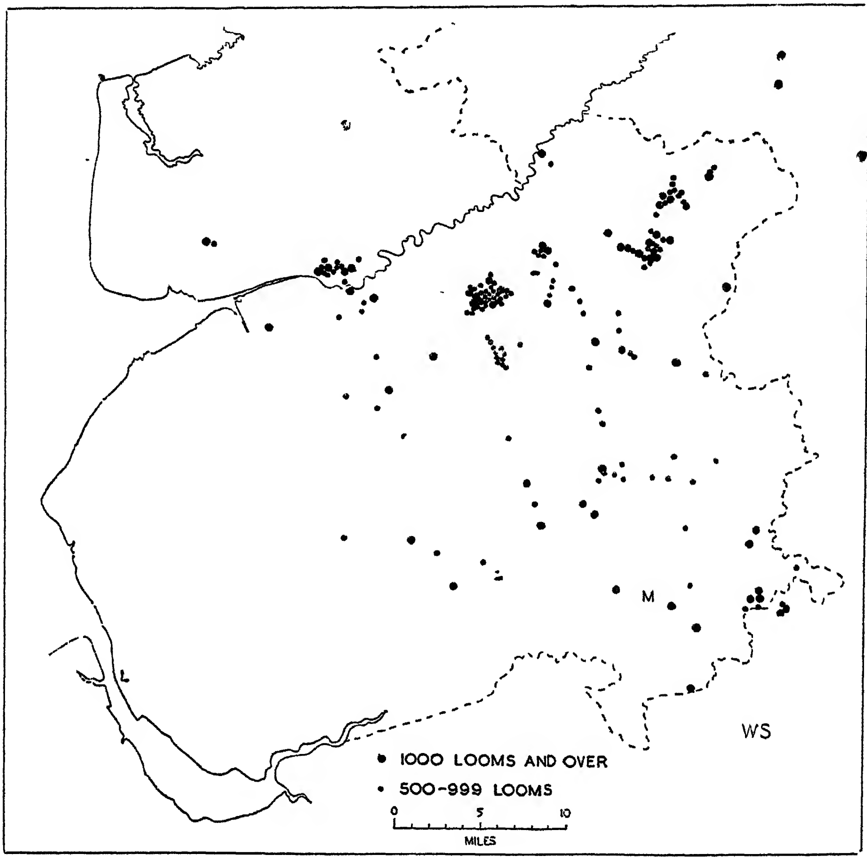

Fig. 67

DECREASED PLANT IN LANCASHIRE COTTON WEAVING SHEDS, 1929–1936

Decreases of under 500 looms have been omitted for the sake of clarity. The map shows decreases both in sheds still running in 1936 and in sheds wholly closed down at that date. L and M are on the site of the Town Halls of Liverpool and Manchester respectively. The period between 1929 and 1936 was the period of most rapid decline of looms 'in place'.

sheds. The average Lancashire spinning-mill in 1936 had 94,469 mule-equivalent spindles and the average Lancashire weaving shed 671 looms. In the combined mills of the United States, in which spindleage and loomage are balanced so that each may be fully employed, the average spindleage is less than in the average British

TABLE LXXIX

Spindles and Looms in Lancashire in Different Classes of Administrative Area

	County Boroughs	Municipal Boroughs	Urban Districts	Rural Districts
A. Actual numbers				
No. of spindles in thousands (mule equivalent)				
In 1913 . . .	25,858	14,234	18,217	337
In 1936 . . .	21,094	10,437	14,474	165
No. of looms in thousands				
In 1913 . . .	295	245	176	32
In 1936 . . .	175	149	131	30
B. 1936 *compared with* 1913				
No. of spindles				
In 1913 . . .	100·0	100·0	100·0	100·0
In 1936 . . .	81·6	73·3	79·5	48·9
No. of looms				
In 1913 . . .	100·0	100 0	100·0	100·0
In 1936 . . .	59·2	60·9	74·4	93·4

spinning-mill and the average loomage more than in the average British weaving shed.[1] This tendency of the British cotton-spinning mill towards great size has been further emphasized during the inter-war years, for the average mill increased in size from 75,390 spindles in 1913 to 94,469 spindles in 1936,[2] the spindles being mule equivalents in each case, while the average weaving shed changed scarcely at all in the number of its looms, being 641 in 1913 and 671 in 1936. There have been no differential changes in number of spindles as between different classes of administrative area, except a marked decline in the rural districts which had very few spinning-mills at either date. The differential changes in number of looms as between different classes of administrative area has, in contrast, been quite marked. Decline in loomage has been progressively less, passing from boroughs to urban districts and from urban districts to rural districts. Some rural districts had even a positive increase in loomage. This relative increase in the importance of the country, as compared with

[1] The comparison can only be a rough one, for several adjustments are necessary; for example, the combined mills of the U.S.A. make standard lines with a high output per spindle hour.

[2] The mechanics of this increase in size were the closing down of many small antiquated premises and the building of a few large mills as well as decreases in some and increases in other mills existing at both dates.

Map A classifies them according to whether they were still in use as cotton mills in 1940 or whether they had been diverted to other uses or were empty. Map B classifies them according to age. These maps refer to conditions prior to the concentration of industry schemes. The hair line marks the rivers, the unbroken line the canal, the broken line the railways. Map redrawn from a survey by Miss E. Whitham.

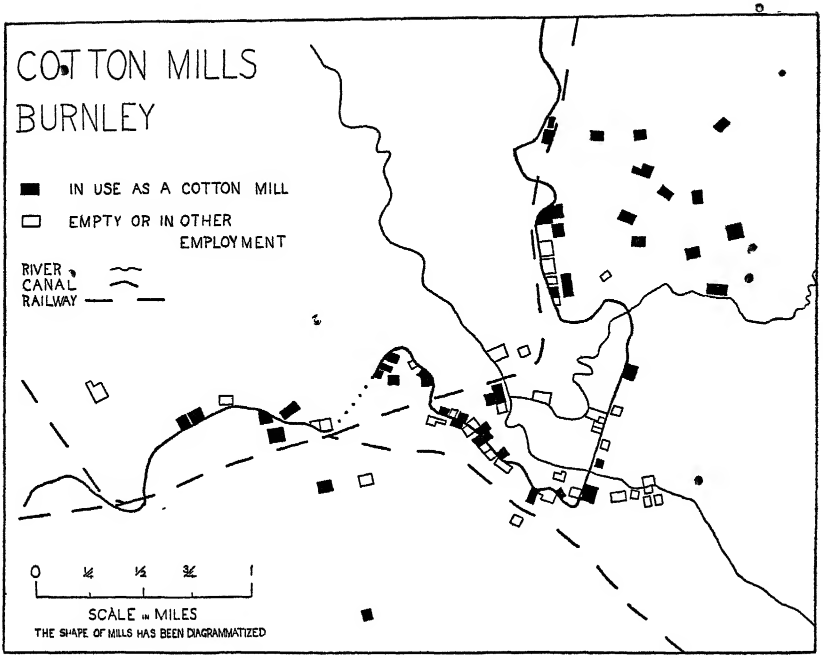

Fig. 68A

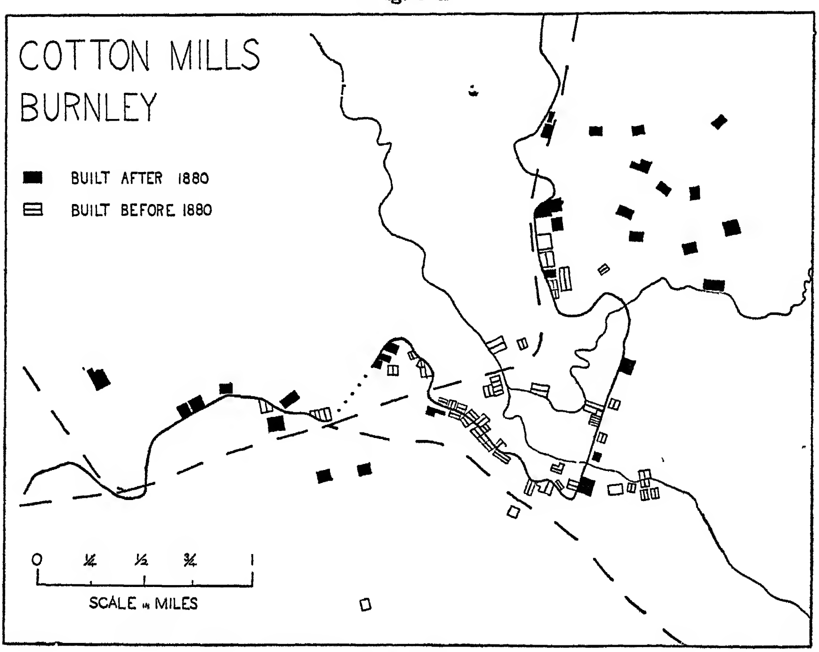

Fig. 68B

BURNLEY COTTON MILLS IN 1940

the town, in weaving was in all probability unaffected by the lower local government rates of the rural areas. There were lower rates, as I have shown,[1] but these constituted a very small proportion (0·3 per cent) of total production costs[2] and de-rating reduced the rate burden on industry since 1929. If rates were a powerful factor they would doubtless have affected spinning as well as weaving. There is, however, a factor peculiar to weaving in the lower wages which weaving sheds in remote areas were permitted to pay in compensation as 'disadvantage allowances'. The remote areas were on the northern, western, and southern margins of the industrial region—in Ribblesdale, Airedale, Wharfedale, on Pendle Hill, in the West Lancashire Plain. The deductions allowed had been considerably reduced from their pre-1920 levels and the effect of the factor doubtless reduced.[3]

TABLE LXXX

Cotton Premises in Burnley according to Site

	River	Canal	Rail	Road
Percentage of total number	9	51	3	37
Percentage not in use as cotton mills in 1940	85	50	—	32
Percentage in use as cotton mills in 1940	15	50	100	68
Percentage constructed prior to 1880	85	71	—	36
Percentage constructed after 1880	15	29	100	64

The fourth trend in detailed distribution is the closing down of premises with riverine and canal-side sites. In plotting premises on large-scale working sheets I formed the impression that many mills with such sites had closed down. In order to check this impression I took Burnley as a random sample area. Cotton premises were mapped for me according to (*a*) whether they were in operation or closed down in the summer of 1940, and (*b*) date of construction.[4] The results are shown in Fig. 68 and in Table LXXX. It will be noticed that the greater number of premises which have ceased to be cotton-mills are on the banks of the River Calder and of the Leeds and Liverpool Canal, and that those which continue to be used as cotton-mills have a site along the road or railway. There

[1] Smith, op. cit., p. 13.
[2] *An Industrial Survey of the Lancashire Area* (1932), p. 280.
[3] See p. 477 above.
[4] The field work was kindly done for me by Miss E. Whitham of Edge Hill Training College.

are very few sites along the railway available for topographical reasons, as a result of cuttings and embankments. But this greater capacity to survive of the rail-side and road-side premises is a function not only of their site, but also of their age, for the riverine and canal-side premises were mostly built prior to 1880, while the rail-side and road-side premises were mostly built after 1880.[1] Riverine and canal-side sites presented great advantages in the nineteenth century, and they were early utilized. The riverine sites had water rights which permitted the use of water-power and of water for process work and steam-raising. The canal-side sites permitted the receipt of coal brought by barges along the canal and also the use of water for process work and for steam-raising. Rail-side, and particularly road-side, sites were not customary until later, but, besides being newer and presumably better-planned premises, they are in contact with what are now the main avenues of transport. The greater part of the raw cotton, cotton yarn, and finished pieces have come to be carried by road and a road-side site presents the most suitable conditions of all from the point of view of present-day transport practice.

[1] R. Robson ('Sizes of Factories and Firms in the Cotton Industry', *Manchester Statistical Society* (1949)), has shown that the size dispersion of spinning mills built after 1900 is different from that of those built before 1900, the mode of the former being 100,000–110,000 mule equivalent spindles and of the latter being 50,000–60,000 mule equivalent spindles.

CHAPTER XI

MANUFACTURE OF CLOTHING

I

THE treatment of the clothing trades in this chapter is a sequel to that of the textile industries, and as such will be confined to the manufacture of clothes from textile materials. The descriptions 'The Clothing Trades' in the Census of Production, 'Manufacture of Clothing (not knitted)' in the Census of Population, and 'Clothing Industry' in the industrial classification of the Ministry of Labour include footwear and headgear as well. The boot and shoe industries will be considered in a later chapter, after leather tanning. Some products of the boot and shoe industries, such as felt slippers, belong to the textile sequence, but these constitute only a proportion of the boot and shoe output.

In this restricted sense clothing is an end-product of textile manufacture, just as tinplate, cutlery, and machinery are end-products of iron and steel manufacture. It has been shown above, in the analysis of the iron and steel industries, that the further the metal product is removed from the initial smelting of the ore the looser become its locational ties with its initial raw materials. Iron smelting is focused on orefield or coalfield, but machinery-makers and foundries are to be found in every centre of population. The tests I have employed[1] to register the degree of this locational mobility in respect of raw materials include (*a*) weight of material per operative, (*b*) value of product per ton, (*c*) Weber's test of loss of weight in the course of manufacture, (*d*) cost of materials as a percentage of value of product.[2] These usually decrease as the product diverges from the initial raw materials. The first, second and third tests cannot be applied in the case of clothing in Great Britain, for weights of materials used in the clothing trades are not given in the Census of Production returns.[2] The weight of material per operative and the loss of weight in the course of manufacture are small and the value of product per ton is high, though these cannot be measured statistically. The test gives the same result as in the iron and steel sequence. The clothing trades need not necessarily be located at the point where textile materials are spun and woven; they are

[1] For previous work in this field see my *Distribution of Population and Location of Industry on Merseyside* (1942). The examples considered there are other than those of the iron and steel and textile sequences.

[2] Note the criticism of the fourth test by P. Sargant Florence, 'The Selection of Industries Suitable for Dispersion into Rural Areas', *Journal Royal Statistical Society*, vol. CVII (1944), footnote, p. 103. The criticism is valid of the use of the ratio as an *automatic* test, but it is of value when supplemented by other evidence.

relatively free to be located elsewhere. They are, in fact, widely dispersed over the face of Britain, and, before the development of clothing factories, they were even more widely dispersed than they are to-day. They do not now display, however, quite the same independence as formerly of the centres of textile production, and they are more closely associated locationally with textile manufacture than is hosiery, which has the same degree of locational mobility with regard to raw materials on the tests employed above. Although clothing industries employ a great variety of textile materials, yet individual factories normally use one textile material in excess of all others. Thus tailoring factories employ chiefly woollen and worsted cloth, apron and overall factories chiefly cotton, shirt and pyjama factories mainly cotton and artificial silk. It is possible for a clothing factory located in a textile district to get the greater part of its materials requirements from that district alone. Moreover, the textile clothing industries differ among themselves as to the precise proportion that cost of materials bears to total value of product and weight of materials to numbers employed so that some branches display a closer association with raw materials than other branches with different proportions.

The clothing industry has been traditionally one of handwork and of homework and has only within living memory become a factory industry. This condition profoundly affects its geographical distribution and must therefore be examined with some care. As a handwork industry carried on at home or in small workshops attached to a house or shop, it was inevitably ubiquitous and as widely dispersed as population itself. This was the more pronounced when all clothing was bespoke and made to individual order. There were village tailors and there were itinerant tailors and itinerant dressmakers, who made those clothes which required more skill than members of the household could themselves muster. The equipment needed, moreover, was small and required scarcely any capital, and there was little, except a fear of being unsuccessful in one's own business, to restrain an apprentice, after serving his time, to set up on his own account. These characteristics of the industry kept the industrial units small and ensured its wide dispersal.

Within living memory these conditions began to change and, once established, factory production immediately began to affect the existing industrial structure and the existing geographical distribution. Witnesses appearing before the Select Committees on Home Work, reporting in 1907 and 1908, traced the effect of factory production in lowering the income of home workers.[1] A shirt manufacturer declared in 1908 that sewing machines driven by power would perform up to four and a half times as much work as a foot-operated

[1] For example, answer to Q. 514 in the *Minutes of Evidence*, Second Committee on Home Work (1908).

TABLE LXXXI

Regional Distribution of Textile Clothing Industries in Great Britain in 1931

	Numbers returned			Percentages			
				Of total in all industries in region		Of total in Gt. Britain	Males of total in Tailoring
	Total	Working on own account	Others	Working on own account	Others	Others	
Greater London	178,457	12,985	165,472	0·34	4·4	37·1	51·7
South-east	29,198	8,228	20,970	0·37	0·9	4·7	51·7
North-east Coast	7,867	1,918	5,949	0·26	0·8	1·3	45·2
Rural North England	6,924	2,014	4,910	0·41	1·0	1·1	52·4
West Riding	68,959	3,906	65,053	0·27	4·4	14·6	29·7
Lancashire–Cheshire	88,053	7,506	80,547	0·29	3·1	18·1	37·1
West Midlands	36,870	5,589	31,281	0·29	1·6	7·0	34·7
East Midlands	25,016	2,821	22,195	0·27	2·1	5·0	35·5
East England	10,531	2,726	7,805	0·38	1·1	1·8	45·3
South-west England	16,075	4,136	11,939	0·49	1·4	2·7	48·0
South Wales	7,811	3,259	4,552	0·51	0·7	1·0	52·7
Rest of Wales	3,132	1,783	1,349	0·67	0·5	0·3	80·0
Scotland	28,852	5,089	23,763	0·27	1·3	5·3	44·2
Great Britain	507,745	61,960	445,785	0·33	2·4	100 0	42 2

From 1931 Census of Population, consisting of Code Nos. 340–3 and excluding those out of work.

sewing machine in a given amount of time. This was a measure of the speeding up of production at that date.[1] The change, however, is by no means yet completed. Of those who returned tailoring and the making of dresses, blouses, overalls, shirts, collars, and under-clothing as their industrial occupation in the 1931 Census, 12·2 per cent were working on their own account.[2] In the 1935 Census of Production firms employing not more than ten persons had 18·1 per cent of the total employed in the tailoring, dressmaking, and millinery trades.[3] The tailors and dressmakers working on their own account were in 1931 widely distributed and very roughly in proportion to population, as Table LXXXI shows. In the industrialized and urbanized parts of Great Britain their percentage to total population over fourteen years old was, in 1931, under 0·35 per cent, but

[1] *Minutes of Evidence*, Second Committee on Home Work (1908), Q. 4228

[2] Excluding knitted goods and excluding those out of work.

[3] These firms, while employing 18·1 per cent, made only 14·3 per cent of the output as returned. They had a lower level of output, in terms of value per person employed.

in rural districts it was above this figure, being greatest of all in rural Wales. These regional differences are exactly what are to be expected, if working on one's own account is to be regarded as a relic among the mass of the industrial population, but still a not unimportant activity among the mass of the rural population. It may be added that those working on their own account, both men and women, were most numerous in the age-groups 35–44 and 45–54, while the operative workers in factories and workshops were most numerous in the age-groups 18–20 and 21–24.[1]

The extent of the change in the tailoring branches of the clothing industry is displayed by Table LXXXII, which gives the percentage distribution of those returning tailoring as their occupation in 1851 and tailoring as their industry in 1931.

TABLE LXXXII

Regional Distribution of Tailoring in Great Britain, 1851–1931

	As per cent of total		1931 as compared with 1851	
	1851	1931	+	—
Greater London	22·0	29·3	7·3	—
South-east	9·4	5·5	—	3·9
North-east Coast	3·1	1·5	—	1·6
Rural North England	3·8	1·4	—	2·4
West Riding	5·8	19·6	13·8	—
Lancashire–Cheshire	11·3	16·9	5·6	—
West Midlands	9·6	7·8	—	1·8
East Midlands	4·2	4·7	0·5	—
East England	6·4	2·3	—	4·1
South-west England	8·0	2·8	—	5·2
Wales	4·8	1·8	—	3·0
Scotland	11·6	6·4	—	5·2

Numbers for 1851 refer to those aged twenty years and over, for 1931 those aged fourteen years and over. The definition of the regions is that of 1931, but there are some discrepancies between Greater London of 1851 and 1931. Greater London of 1851 has been taken as London (so defined) plus extra-metropolitan Middlesex.

In 1931 the industry was much less evenly spread over the country. The percentage shares of all districts had declined, except those of Greater London, the West Riding, Lancashire–Cheshire, and the East Midlands. Many of those areas whose percentage had declined were rural districts with a declining population, but some were industrial districts with an increasing population, such as Central Scotland, the North-east Coast, the West Midlands and South Wales.

[1] To make this statement the numbers given in the Census tables have been adjusted to the smaller range of the size-groups for the earlier ages.

The three major districts (Greater London, West Riding, and Lancashire–Cheshire) had two-thirds of the total in 1931 as compared with over one-third (39 per cent) in 1851. The general diffusion of tailoring has thus had regional concentrations superimposed on it. The major regional concentrations are Greater London, the West Riding, and Lancashire–Cheshire, and the minor concentrations expressed in proportion to population, the East Midlands, the West Midlands, the West of Scotland, and Gloucester.

The major areas of regional concentration present different characteristics from the diffused tailoring elsewhere. The two most outstanding of these different characteristics are the existence of tailoring factories and, secondly, the dominance of female labour. In both these respects the 'new' tailoring is contrasted with the 'old' tailoring, most sharply in the West Riding and, though less sharply, in Lancashire–Cheshire and in the Midlands. It is not as pronounced in Greater London, owing to the influence of the high-class trade with its small workshops and owing to the general conditions of London industry, which have encouraged the survival of small-scale production and delayed the adoption of mechanical equipment.[1] The 'old' tailoring involved the completion of each article by a single craftsman; the 'new' tailoring involves the subdivision of processes among the individual members of a team in a workshop and between groups of workers in a factory, just as in textile manufacture there are carders and spinners, winders and weavers. Factory methods of manufacture whereby an individual becomes skilled in a limited range or in a single process have been applied to the making of clothes as well as to the manufacture of cloth. The 'old' and the 'new' are contrasted in another respect. The 'old' tailoring employed the minimum of mechanical aid; the 'new' employs mechanical devices whenever they will speed up and cheapen production. It is the subdivision work and the employment of machines that have been responsible for the increasing percentage of women in tailoring factories.[2] In 1851 there were 115,471 males and 17,244 females in England and Wales who returned tailoring as their occupation; in 1931 the numbers attributed to tailoring as an industry were 111,522 men and 153,899 women. The proportion of women in 1931 was highest in the West Riding and, within the West Riding, in Leeds, where the factory organization of tailoring has developed furthest. The factors which have encouraged factory production are the rise in the standard of living of the mass of the population, which has provided a vast market for factory-made

[1] This point is developed in Chapter I of vol. II of the *New Survey of London Life and Labour* (1931).

[2] This does not necessarily imply large factory premises, though some firms have large premises. It was easy to start in clothing manufacture with only a limited capital: machines could be obtained on hire-purchase terms, and cloth manufacturers would give credit. It is held that, even in heavy clothing manufacture, the largest efficient unit is a factory of 750 workers (*Heavy Clothing.* Working Party Reports (1947), p. 53).

clothes, the greater cheapness of factory production which has enlarged that market, the subdivisional methods introduced by the Jews, and the bulk orders for uniforms for the Services, the police, the railways, the tramways and omnibus companies. It is no doubt possible for mechanical equipment and subdivision of labour in

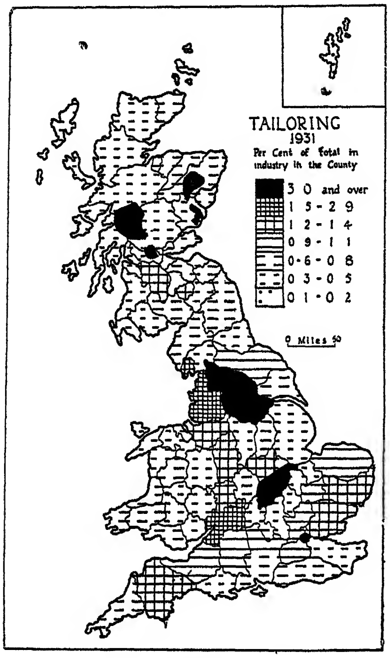

Fig. 69A

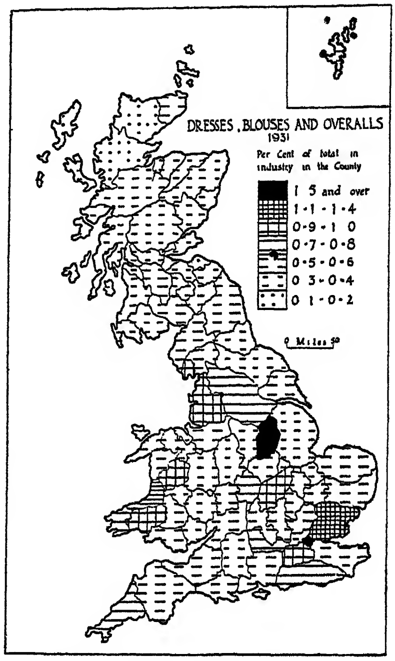

Fig. 69B

PERSONS AT WORK IN TAILORING AND IN THE MAKING OF DRESSES, BLOUSES AND OVERALLS IN GREAT BRITAIN BY COUNTIES, 1931

Maps drawn from county data in 1931 Population Census, Industry Tables, and expressed as a percentage of the total at work, male and female combined The two maps have not been drawn on identical scales of shading.

factory production to develop still further, but there is a powerful deterrent to complete specialization and standardization in the important part played by fashion. Fashions change from year to year, and this sets a limit to standardization and to production for stock.[1]

[1] There is a substantial seasonal rhythm dictated by these changes which is especially pronounced in retail bespoke work, and tailoring factories usually try to smooth out such seasonal variation by making a variety of articles in demand at different seasons (C. Saunders, *Seasonal Variations in Employment* (1936)). Thus overcoats are made in late summer preparatory to winter, ready-made suits in winter preparatory to spring, bespoke suits in spring and summer. Seasonal variation itself imposes limitations on factory production for during rush periods

The 1935 Census of Production was able to distinguish the three varieties of tailoring and dressmaking—wholesale, wholesale bespoke, and retail bespoke—and, as these display somewhat different regional distributions, it is instructive to consider them separately. The first deals with ready-made suits, coats, or mantles; the second with bespoke garments made in a factory by subdivision methods and a good deal of machining; the third with bespoke work in small workshops and with a minimum of machining.[1] Of the total numbers employed in these three branches as returned to the 1935 Census of Production, 68·5 per cent were in the first, 17·9 per cent in the second, and 13·6 per cent in the third. These returns of the 1935 Census, however, exclude those establishments employing ten persons and under, and there is no doubt that the third group is under-represented.

Retail bespoke work is widely dispersed, as Table LXXXIII shows, and this wide dispersion would be even more pronounced if the small firms employing ten and under had been included. London has a predominantly large share of retail bespoke work, for many who live elsewhere than in London have their clothes made in the West End. S. P. Dobbs estimated that a quarter of the handicraft tailors were in the West End of London, and he placed the most important centres after London as Manchester, Glasgow, Liverpool, and Edinburgh.[2] For the more expensive clothes some of the work is done on the premises where the order is given and the fitting made, some near to the shop on premises where the journeyman tailor hires a sitting, and some at the journeyman's own home. Few still follow the practice of the 'old' tailoring whereby one man completed the whole suit, for there are cutters, coat hands, trouser hands, waistcoat hands: there is some machining, and women are employed for the less skilled jobs, such as linings, buttonholes, and buttons. In London much of the sewing in the retail bespoke trade is in the side-streets within the West End, and in other cities it is in the side streets within the business centres. Of the 3,038 tailoring establishments on the list of the Ministry of Labour in Greater London in 1929, 1,291 were in the West End, 624 in the City and in Stepney adjoining it to the east, and only 319 in Outer London beyond the County of London boundary.[3]

it is a common practice to put work out to sub-contractors which thus act as shock absorbers and limit the amount of idle factory space which the factories need carry. Small workshops and even home workers thus survive in association with factories, expecially in London. The problem of seasonal variation of employment gave considerable concern to the Working Parties. See *Heavy Clothing*, *Light Clothing* and *Rubber Proofed Clothing*, Working Party Reports (1947).

[1] The average number employed per establishment was 104 in each of the two wholesale groups, but 29 in the retail bespoke group. The average net output per person employed was, in 1935, £143, £149, and £204 respectively.

[2] S. P. Dobbs, *The Clothing Workers of Great Britain* (1928), p. 11.

[3] *New Survey of London Life and Labour*, vol. II (1931), p. 348.

TABLE LXXXIII

Regional Distribution of Textile Clothing Industries in Great Britain, 1924–1935

	Average number employed as percentage of total in Great Britain								
	Tailoring, dressmaking			Tailoring, dressmaking			Rain-proofs 1935	Overalls 1935	Shirts 1935
	1924	1930	1935	Wholesale 1935	Wholesale bespoke 1935	Retail bespoke 1935			
Greater London	35·5	34·6	36·9	38·3	25·9	46·7	8·4	16·4	34·9
Lancashire–Cheshire	18·4	19·0	18·5	14·2	4·6	8·7	59·4	38·8	29·5
West Riding	14·9	15·4	17·0	22·4	46·1	5·8	10·4	12·0	7·2
North-east Coast	1·2	1·2	1·4	1·2	—	3·7		0·8	0·2
West Midlands	4·8	5·0	5·0	5·6	3·7	3·6		13·3	3·2
East Midlands			6·8	8·0	5·7	3·5		5·9	6·3
Welsh Border			1·7	2·0		1·5			1·9
South-east			2·4	0·8		7·2			0·8
South-west	16·7	17·8	2·1	1·2		3·2	12·5		6·0
East			1·8	2·0	2·9	3·5		6·7	
Cumberland–Westmorland			0·2	0·2		0·1			2·2
Wales	0·8	0·6	0·5			1·0			1·2
West of Scotland	5·3	4·7	4·4	3·7		4·6			5·5
Rest of Scotland	2·5	1·7	1·3	0·4	4·9	6·8	9·3	6·1	1·1
	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0

Calculated from Returns of Census of Production.

The wholesale manufacture of suits, coats, and mantles is a factory business, whether they are ready-made or made to order. The finished garments are distributed, of course, to all parts of the country. This is much less diffused than retail bespoke work and much more concentrated into a limited number of regions. Materials, fuel, and electricity form a larger proportion of value of output in wholesale tailoring than in retail bespoke work.[1] While retail bespoke work may be entirely independent in location with regard to raw materials, that is, cloth, wholesale tailoring is conspicuously less independent. The two most important factory areas are Greater London and the West Riding,[2] the one with an advertising value and the other within the district making the woollen and worsted cloths which comprise the largest single item among the piece goods used. The proportion of Greater London in the wholesale trade is not as high as in the retail bespoke trade, a result of the expensive character of London's retail trade and of the positive attraction exerted by industrial areas to a factory form of manufacture. Indeed, the average number employed per tailoring factory in 1935 was 76 in Greater London as compared with 185 in the West Riding. Within London the tailoring factories are in the West End to only a limited extent. Of a total of 2,236 establishments making ready-made suits in 1929, the West End had 338, and of a total of 2,253 making wholesale mantles the West End had 429, while the numbers in the City and East End together were 1,369 and 1,314 respectively.[3] While retail bespoke tailoring in London is chiefly in the West End, wholesale tailoring, which requires less expensive premises, is chiefly in the East End. This is exactly what would be expected on general grounds. In the West Riding the tailoring factories are chiefly in Leeds.[4] Leeds is not a cloth manufacturing centre and is not the organizing centre of textile manufacture in the West Riding in the same way that Manchester is of the Lancashire cotton industry. It is Bradford and not Leeds that is the nearest equivalent to Manchester as an organizing centre. But Leeds is a making-up centre, equal with Manchester. The Leeds factories draw their labour not only from Leeds itself, but also from the mining villages and towns lying immediately to the east, which are not involved in textile manufacture proper and which have the female labour available which tailoring factories require. The percentage share of Leeds of the wholesale factory trade is increasing: for all tailoring, dressmaking, and millinery, the share of the West Riding had risen from 14·9 per cent in 1924 to 17·0 per cent in 1935, and the increase would be much more striking if it were possible to

[1] The percentages were in 1935, 55·6 for wholesale, 56·2 for wholesale bespoke, and 35·9 for retail bespoke.

[2] London has the greater share of the women's mantles and Yorkshire of the men's suits, being 50 per cent and 28 per cent respectively of the country's production in 1942.

[3] *New Survey of London Life and Labour*, vol. II (1931), p 328.

[4] No less than 25·6 per cent of its total insured in 1937 were in tailoring.

separate wholesale tailoring from the rest for 1924. Ministry of Labour returns attribute 16·5 per cent of the tailoring in Great Britain in 1923 to Leeds and 23·8 per cent in 1937. The Bristol clothing factories which make for a similar market seem to have been the chief sufferers from this growth of the Leeds industry. There are some tailoring factories in the West Riding elsewhere than in Leeds. Huddersfield does a similar trade on a smaller scale. Hebden Bridge, together with Mytholmroyd, make up corduroy and moleskin clothes, but these fabrics are less in demand than formerly owing to changes in taste, and the factories have turned over in part to overalls, which are now worn over ordinary clothes in place of corduroys. Lancashire and Cheshire have relatively few tailoring factories. They have other clothing factories in great numbers, as will appear shortly, for they have concentrated their attention on kinds of clothing made from materials other than woollens and worsteds. Leeds is in a wool textile district whereas Manchester is in a cotton district, and the factory clothing industry is to some extent modelled by the kind of textiles made in the neighbourhood. The Manchester tailoring factories make women's mantles and skirts, and in this branch of the trade Manchester is as important as Leeds. Manchester has also many dressmaking factories, making ready-made frocks and blouses of cotton and artificial silk from fabrics woven in the district of which Manchester is a regional capital. Wigan is a secondary centre. In the Midlands there are tailoring factories in scattered localities—Walsall, Birmingham, Kettering, Leicester, and Nottingham—but nowhere do they form the major industry of the place.

The manufacture of rainproofs is frequently distinct from other tailoring. Raincoats, which are not rubber-proofed, may be made by wholesale tailoring manufacturers, as well as by waterproof manufacturers proper. On the other hand, the larger waterproof manufacturers frequently make other rubber goods in addition. The industry is thus tied at one end to tailoring and at the other to rubber manufacture. It is focused very largely into the single region of Lancashire–Cheshire and within this region into Manchester–Salford. Of the textile materials employed, cotton forms over two-thirds of the total and the localization of the industry in Manchester is to that extent an effect of the source of raw materials. Moreover, Manchester is one of the centres of rubber manufacture. Thus, having the materials available within the region and having experience in factory clothing manufacture, Manchester–Salford has developed waterproof manufacture more than any other part of Britain. Rainproofs are made also to a lesser extent in the other clothing districts of Greater London and of the West Riding, which possess experience in clothing manufacture, but have not the raw materials chiefly required.

The other clothing industries making up textile materials which will be considered here may be described as the light clothing trades —frocks and blouses, shirts and pyjamas, overalls and underclothing (excluding knitted goods).[1] The regional distribution of shirts, collars, and underclothing, as given by the returns of the Censuses of Production and of Population, generally coincide, and it is clear that the two major districts are Greater London and Lancashire–Cheshire, which have over three-fifths of the total number employed in Great Britain.[2] The average factory in Lancashire is a little larger than in London in accordance with the general rule in most industries. Within Lancashire, Manchester–Salford has three-fifths of the total; in London, Camberwell and Hackney provide the residences of the factory workers, but the factories themselves are chiefly in the City and East End.[3] It is in the clothing districts that shirt-making, like the manufacture of raincoats and waterproofs, has become focused owing to the presence of experience of factory clothing manufacture and owing particularly to the presence of the machinists required to work in such factories. In addition, London has a certain amount of prestige as a fashion centre, and Lancashire has the advantage of proximity to raw materials, for nearly nine-tenths of the textile fabrics used are cotton and artificial silk. The Ministry of Labour returns, which include overalls as well, show a marked increase in Lancashire as between 1923 and 1937 and a percentage decrease in London and the Home Counties.[4] The greater part of the growth of the industry went, therefore, into factory districts in the proximity of the raw material employed. Again, it may be inferred that, with the growth of factory manufacture and the consequential decrease in the share that labour costs bear to total production costs, the localizing effect of raw materials has become more pronounced.[5] In the shirt, collar, and underwear industry, cost of materials, fuel, and electricity, contributed in 1935 60·5 per cent of value of products. The regional distribution of overall manufacture is a little different. London has a smaller share than in shirt-making, and Lancashire–Cheshire, the West Riding, and the West Midlands a considerably larger share. The particular places involved, which

[1] The grouping of these industries for the statistical purposes of the Census of Production, of the Census of Population, and of the Ministry of Labour did not coincide. The Census of Production placed dressmaking with tailoring, the Census of Population with overalls and the Ministry of Labour with millinery. Shirts, collars, and underclothing were grouped together in the Census of Production and in the Census of Population, but the Ministry of Labour added overalls to the group. The Standard Industrial Classification has now resolved these discrepancies for contemporary returns.

[2] The Londonderry district in Northern Ireland also makes shirts on a large scale, but it is excluded from Table LXXXII.

[3] *New Survey of London Life and Labour*, vol. II (1931), p. 328.

[4] Tables prepared by the Ministry of Labour for the Barlow Commission.

[5] Weber noticed the same disappearance of production in industry generally from areas of consumption on the decay of handicraft industry. He attributed it, however, to the use of fuel as a result of factory manufacture which brought into operation his loss of weight factor (Weber, op. cit., p. 75).

include manufacturing towns and large cities, are all industrial and have a large local demand for men's overalls and women's aprons. Although not the home of clothing industries, apart from its normal share of tailoring, Liverpool has a rapidly growing manufacture of overalls. It is not to be expected that this business, a manufacture of industrial garments which are standardized and immune from short-term changes in style, would be an industry in which London would specialize.

TABLE LXXXIV

Regional Distribution of Textile Clothing Industries in Great Britain 1923 and 1937

	Percentage of total insured		Tailoring		Dress-making, millinery		Shirts, collars, under-clothing	
	1923	1937	1923	1937	1923	1937	1923	1937
London and Home Counties	22·4	26·1	26·7	27·7	54·8	73·8	33·6	29·2
Lancashire	15·7	13·8	15·1	15·7	14·4	8·1	19·1	30·0
West Riding, Derby, and Nottingham	13·0	12·2	22·8	28·5	5·9	3·6	15·7	14·7
West and East Midlands	11·2	11·7	8·7	8·4	5·4	3·6	6·9	8·3
North-east Coast	5·7	4·9	1·7	1·3	1·5	1·7	0·8	0·5
Mid-Scotland	7·3	6·6	6·4	5·9	4·8	3·1	5·2	4·8
Glamorgan and Monmouth	4·2	3·3	1·0	0·8	0·5	0·3	0·3	0·8

Calculated from tables in Appendix I to the Memorandum of Evidence submitted by the Ministry of Labour to the Barlow Commission.

To conclude this discussion of the textile clothing trades I want to draw some general conclusions on trends in distribution. At the time of the Select Committees on Home Work in the first decade of this century, there was some discussion of the effects of inter-regional competition in the clothing trades. A witness from Leicester before the 1908 Committee declared, 'it is a well-known fact in the tailoring trade, that you can get work done cheaper in some parts of the country than in others'.[1] A Factory Inspector gave it as her opinion that prices paid, presumably for home work, varied 'very considerably' in wholesale tailoring and 'considerably' in shirt-making.[2] The London rates were usually the highest, the West of England rates among the lowest. There were many out-workers in the villages around Bristol and Colchester, for example.[3] It was in the villages that rates were lowest of all. The Board of Trade Earnings and Hours Enquiry of 1906 brings out these differences

[1] *Minutes of Evidence*, 1908 Committee, Q. 1014.
[2] *Minutes of Evidence*, 1907 Committee, Q. 886.
[3] *Minutes of Evidence*, 1907 Committee, Q. 460.

very clearly for the non-factory trades. Thus, for women skirt-makers working in dress and millinery workshops, but living out, the average earnings for those working full time in the last pay week of September 1906 were 15*s.* 7*d.* for London, 12*s.* 2*d.* for Lancashire and Cheshire, 12*s.* 1*d.* for Yorkshire (excluding Cleveland), 11*s.* 0*d.* for the Northern Counties (including Cleveland), 10*s.* 9*d.* for the North and West Midlands, 10*s.* 3*d.* for the South Midlands and Eastern Counties, 11*s.* 3*d.* for the South-eastern Counties, 9*s.* 5*d.* for the South-west Counties, and 8*s.* 7*d.* for Wales and Monmouth. The lower earnings in rural districts and particularly in the remote south-west and in Wales are neatly displayed. Though the returns of earnings in bespoke tailoring were not presented with the same regional detail, the same regional differences appear to have been present.

This pattern of regional differences in earnings during the first decade of this century in non-factory trades, was not repeated in the factory trades. The average earnings of women power machinists, for example, working full time during the same week, were lower in London than in industrial Lancashire, Yorkshire, and Scotland. They also seem to have been lower in Bristol than in the Midlands and lower in Norwich than in the rest of the Eastern Counties. The regional pattern of earnings displayed considerable confusion, though this much can be said, that earnings were highest in the industrial districts with a tradition of factory work, and it may be presumed with a tradition of efficiency in factory work, and lowest in towns such as Norwich and Bristol in the midst of rural areas with decaying home work industries and with a limited experience of factory production. Earnings are the product jointly of wage-rates and of efficiency, and it may be argued that the districts accustomed to factory production were the districts where efficiency of the factory operative was greatest.[1] It would thus appear that the conditions governing the distribution of clothing factories are not the same as the conditions governing the distribution of handicraft clothing trades with home-workers; differences of wage-rates would have a greater effect on the latter, differences of efficiency on the former.

With the dominance, or sub-dominance, of factory production to-day, the industrial districts are increasing their proportion of the textile clothing industries, and they have in the aggregate a greater proportion of those employed in these clothing industries than they have of the total population of the country. Further, the textile clothing industries are concentrated into a few industrial regions, of which Greater London, the West Riding, and Lancashire, are the chief, and the degree of concentration into these major regions was

[1] Since writing the above I have read R. H. Tawney's *Minimum Rates in the Tailoring Industry* (1915). He makes the same points, and adds a further factor to explain regional differences in earnings, in that alternative employment available to men and women differed in each region.

increasing during the inter-war period. These trends are clearly displayed in the returns of the Ministry of Labour for 1923 and 1937, calculated as percentages in Table LXXXIV. The heightened regional concentration between 1923 and 1937 was particularly clearly marked in the West Riding in respect of tailoring, in Lancashire in respect of the shirt, collar, underclothing, and overall group, and in Greater London in respect of dressmaking and millinery. The greater concentration of tailoring into the West Riding is presumably due to the efficiency of factory production in Leeds and of the shirt-overall group into Lancashire to the efficiency of factory production in Manchester–Salford, but the greater concentration of dressmaking and millinery into Greater London is due also to the fashion appeal of the article made in the metropolitan centre. The greater concentration of tailoring into the West Riding and of the shirt-overall group into Lancashire is, further, a move towards the dominant materials used in these branches of the clothing trades, being woollen and worsted cloth in the one instance and cotton and artificial silk fabric in the other. Greater London possesses no such proximity to raw materials and its share of all branches of the textile clothing industries, taken in the aggregate, had increased during the inter-war period less than its share of the total population of Great Britain. It is true that its share of dressmaking and millinery has increased greatly, but these employ the lightest of materials; its share of the shirt-overall group, employing heavier materials, has actually declined. The increasing urbanization and increasing concentration of textile clothing manufacture into a few districts is contrary to trends in hosiery production (which is becoming more widely dispersed) and, indeed, in many other industries whose mobility with regard to raw materials is comparatively high. It is due very largely to the fact that this group of trades is passing from handicraft to factory manufacture and that in consequence the relative influence of materials as a localizing factor is becoming more pronounced. In a sense the clothing trades are at the same stage which the manufacturing textile industries were passing through a century ago, not only in respect of industrial structure, but also in respect of type of geographical distribution.[1]

[1] The pattern of change since 1939 is not easy to interpret. In tailoring there has been considerable decline both actually and relatively in the numbers in the West Riding, but an increase in most other areas, especially in the Northern and Welsh regions. In dressmaking there has been decline in the South-east, an increase in the Northern and Welsh but especially in the North Midland regions. It would seem as if the main centres were losing ground but what inferences should be drawn from this are far from clear. There is secondly, an increase in the Development Areas. This much is clear, for it is the result of positive government encouragement to which clothing manufacture as well as electrical engineering, both mobile industries, have been amenable.

CHAPTER XII

LEATHER AND BOOT AND SHOE MANUFACTURE

THE leather industries provide as neat an example as the iron and steel trades of the diminishing effects of source of materials on localization as the product diverges progressively from its original form. Cost of materials, fuel, and electricity, expressed as a percentage of value of products, according to the returns of the 1935 Census of Production, was 69·8 per cent in leather tanning and dressing, but 54·0 per cent in the manufacture of finished leather goods and 53·0 per cent in the manufacture of boots and shoes.[1] Within the group described as 'leather tanning and dressing' the percentage in 1930 for those establishments tanning only was 77·0 per cent, but for those both tanning and dressing 70·5 per cent, and for those dressing only 74·1 per cent, the percentage for the whole group in 1930 being 72·7. In the tanneries, therefore, materials contribute largely to total costs, and we should expect raw materials to exercise a marked effect on their location. In the finished leather industries, in contrast, materials contribute a much smaller percentage of total costs, and we may expect the distribution of such leather manufacture to be relatively independent of its raw materials. This distinction in location between tanning, on the one hand, and the finished leather industries, on the other, is supported by the second test which may be applied in this respect; that is, the weight of material per person employed. For tanning and dressing, this amounted in 1935 to something over 11 tons, but for leather goods approximately 1 ton, and for boots and shoes approximately half a ton.[2] These qualities are reflected in a third condition, that of the proportion of women employed, being 12·2 per cent of the total in leather tanning and dressing, 43·7 per cent in boots and shoes, and 63·3 per cent in leather goods. Tanning is a heavy industry and employs mainly male labour, but it is also an obnoxious industry and employs little female labour for this reason, too. The sex ratio, of course, is not a *test* of the mobility of an industry with regard to its materials, but

[1] The manufacture of machine belting is included with tanning and dressing; the leather goods trade includes all manufactured leather, except machine belting, boots and shoes, gloves, hat leather, book-binding leather, and probably machinery leather.

[2] The figure for tanning and dressing has been arrived at from the returns of the 1935 Census of Production, together with the table giving consumption of tanning materials in 1937 in the *Leather Trades Year Book* for 1938. The figure for leather goods and for boots and shoes has been calculated from the returns of the 1935 Census, but not all materials are differentiated by weight, and the true figure is doubtless higher than that stated in the text, but it is not very much higher and the contrast with tanning would not be vitiated.

materials to total costs as well as of weight of material, their provenance will affect the distribution of leather tanning.

The cattle and sheep districts of the country are not now the direct source of hides and skins, for the meat is more valuable than the skin, and hides and skins become available to the tanner at the points where stock are slaughtered. Slaughtering on the farm is now practised to only a limited extent in Britain, most stock being slaughtered in or near the towns, and the town slaughter-houses are the chief sources of hides and skins in bulk. There were 142 hide and skin markets in Great Britain listed in the 1938 issue of the *Leather Trades Year Book*: of these only ten in England and Wales and two in Scotland were in places whose administrative status was lower than that of a borough. Such non-borough hide and skin markets were mostly in stock districts, like St. Boswells in the Tweed Valley or Nantwich in South Cheshire, but it is clearly the urban demand for meat which determines the present distribution of the points at which hides and skins become available to the tanner. It might be expected that tanneries would be drawn to the large centres of population where hides and skins are thus available in bulk. The urban areas are not ignored by tanneries, but it is usually urban areas of a special kind that are involved. Most tanners to-day are specialists and handle only a small range of hides or a small range of skins. No single tannery could handle the whole range of hides and skins produced in any abattoir and few single abattoirs would be able to supply sufficient hides or sufficient skins of one sort to keep a specialist tannery in full production. The country tanneries which tan hides and skins of varying kinds and in small quantities could be located by the hide and skin resources of a farming region, but country tanneries of this sort are now few in number.

The points where the largest supplies of hides and skins are available and where any particular tanner is most likely to obtain the range of hides or skins that he requires, are the ports through which imports come from abroad. A port site has, incidentally, the additional advantage of greater ease of effluent disposal. The importing ports are comparatively few in number and the quantities of hides and skins available at any one port are correspondingly increased. The percentages imported by particular ports in 1913 and in 1937 are set out in Table LXXXV, and it is clear that many fewer ports are involved in the import of hides and sheepskins than in the export of British hides and sheepskins from British stock. Export is widely dispersed among many ports, just as the origin of hides and skins within Britain is widely dispersed, though export tends to be greatest from general ports, where they are facilities for export to a wide range of destinations. The hides now enter Britain mainly through the ports of northern England, especially Liverpool. Merseyside, together with the lower Mersey Valley, as will appear

TABLE LXXXV

Imports and Exports of Hides and Skins by Ports in Great Britain

	As percentage of total in each year in Great Britain					
	Hides			Sheep- and lamb-skins		
	Imports		Exports of British origin	Imports		Exports of British origin
	1913	1937	1937	1913	1937	1937
London	31	24	41	71	58	31
Liverpool	37	53	25	6	7	13
Bristol	5	3	3	—	—	—
Hull	14	9	—	2	5	—
Southampton	8	5	—	20	18	—
Glasgow	2	1	3	—	10	—
Other ports	3	5	28	1	2	56
	100	100	100	100	100	100

Calculated from raw data in the form of hundredweights in the *Annual Statement of the Trade of the United Kingdom.*

TABLE LXXXVI

Regional Distribution of Tanning and Currying in 1851 and 1931

	As percentage of total in Great Britain					
	Tanners and Curriers	Tanning, Currying and Leather Dressing	Tanner	Tanyard Worker	Currier	Currier and Leather Dresser
	1851	1931	1851	1931	1851	1931
Greater London	22·0	12·9	17·5	6·6	25·2	19·4
South-east England	8·7	7·3	10·8	8·3	7·1	5·8
North-east Coast	3·9	1·0	4·3	0·7	3·7	0·9
Rural North England	5·5	3·4	5·8	6·1	5·3	0·9
West Riding	7·0	10·0	6·0	7·3	7·7	11·2
Lancashire–Cheshire	8·8	28·6	9·3	34·9	8·4	12·5
West Midlands	10·1	8·3	9·3	13·1	10·7	9·9
East Midlands	5·2	13·8	3·4	5·5	6·5	24·6
East England	4·6	2·2	4·2	1·4	4·8	2·0
South-west England	10·2	4·2	14·4	4·0	7·2	6·3
Wales	4·7	1·1	5·4	1·6	4·3	1·4
Scotland	9·3	7·2	9·6	10·5	9·1	5·1
	100·0	100·0	100·0	100·0	100·0	100·0

The data for 1851 refer to males of twenty years and over, for 1931 to males and females of fourteen years and over. The percentages have been calculated from the Occupation Tables, except the 1931 column for Tanning, Currying and Leather Dressing.

later, is the largest single centre of hide tanning in the country. As an importer of hides, the Port of Liverpool was more important in 1937 than in 1913. Sheep- and lambskins, in contrast, entered the country mainly through the ports of the South of England, though this was not as pronounced as formerly, and London had a large re-export trade. From these differences between northern and southern ports in the nature of their import we should expect some differences in the kind of tanning in which each part of the country specializes. The differences which do, in fact, exist, will emerge later.

A tanning industry uses large quantities of tanning agents. The consumption of vegetable tanning agents in 1937 was 133,200 tons, and of hides and skins in 1935 approximately 200,000 tons.[1] In addition, chemical tanning agents are used, but the weight of these would appear to be a mere fraction of that of the vegetable tanning agents. It is to be expected, therefore, that tanning agents will operate as a factor in locating the tanning industry. Of the vegetable tanning agents only oak bark is of British origin, and this, although the initial basic tanning material of this country, is now employed in only small quantities. In 1924 British oak bark represented only 5·6 per cent of the weight of all vegetable tanning substances used by a large sample of firms, but oak bark is perhaps the weakest of all tanning agents now employed, and it constituted much less than this percentage in terms of tannin units. The vegetable tanning agents consumed by British tanneries expressed as a percentage of the total and adjusted to tannin units in order to take into account their varying strength, are set out for sample years in Table LXXXVII. The decreasing use of oak, larch, and chestnut, and the increasing use of wattle and quebracho are clearly brought out.[2] As all these tanning agents, with the single exception of oak bark, are imported, the importing ports are the points where they originate from the point of view of the location of the tanning industry. The effect of tanning agents, as well as of imported hides and skins, coincide, and a port location of vegetable tanning is thereby encouraged. The *Annual Statement of the Trade of the United Kingdom* does not give the ports through which tanning materials enter Britain, but from what information is available it would appear that the ports which import hides and skins are equally involved in the import of tanning agents.

The dominance of the ports in leather tanning is a function of the import of hides and skins and of tanning agents, and is a function of the specialist character of British tanning at the present day.

[1] The figure for tanning agents is drawn from the *Leather Trades Year Book* and for hides and skins from the Census of Production.

[2] Different tanning agents produce leathers of differing characteristics. Oak bark leather is described as tough and mellow, wattle as soft, oak and valonia together as hard and mellow, hemlock as hard and dense (E. J. C. Swaysland, *Boot and Shoe Design and Manufacture* (1905)).

Widely dispersed country tanneries formerly dominated the industry. Hides and skins were obtained locally and oak bark was got from the woodlands. Tanneries operated only on a small scale and were not infrequently, in their smaller manifestations, an adjunct to a farmer's business and worked by farm labour as an additional department of the farm. They had need to be widely dispersed in order to obtain access to their dispersed materials. The bulkiest of these in the days of oak bark tanning was the oak bark itself, whose strength is so much less than most of the tanning agents employed to-day. This tended to locate tanning in the woodlands, just as charcoal iron smelting was located in the woodlands.[1] Bark, moreover, is relatively fragile, and this factor would still further emphasize a woodland site. Water was available in such rural situations in much greater quantities than in the towns before the development of urban piped water supplies drawn from a distance.

TABLE LXXXVII

Consumption of Vegetable Tanning Agents in Great Britain

	Tannin content	As percentage of total tannin units		
		1913	1922	1939
Oak bark	11	3·0	2·6	1·5* (Oak bark and Larch bark)
Larch bark	10	0·2	0·2	
Oak extract	27	—	—	0·6
Chestnut extract	28	29·3	16·6	8·4
Wattle bark	34	8·3	20·4	4·3
Wattle extract	60	—	9·2	28·2
Myrobalams and extract	32	21·3	20·0	20·3
Gambier	36	3·8	3·3	0·9
Quebracho logs and extract	63	11·6	15·9	26·3
Sumac	28	4·6	3·4	1·4
Valonia	31	13·6	4·6	2·0
Others	—	4·3	3·8	6·1
	—	100·0	100·0	100·0

* Assuming the same quantities as in 1937.

These small rural tanneries are now greatly diminished in number and constitute no more than one in eight of the tanneries in Great Britain. They contribute very much less than one-eighth, of course, of the total output of tanned leather. The extent of the change from a dispersed rural distribution to a nuclear distribution around the ports and urbanized districts is shown in Table LXXXVI, which gives the regional distribution of tanning in 1851 and 1931 in terms

[1] According to a study of the German leather and shoe industry by A. Link in 1913, the weight of oak bark was two and a half times that of hides (quoted by E. M. Hoover, *Location Theory and the Shoe and Leather Industries* (1937), p. 119).

of the Census regions of 1931. London was already an important tanning centre in 1851 and, in fact, it has lost much ground, both actually and relatively, since that date. It was the first port to develop tanning on a large scale. The wider dispersion of tanning in 1851 than in 1931 and especially the much more important position of tanning in the more remote rural regions of South-west England and of Wales, is abundantly clear. While tanning in most districts declined, it grew in Lancashire and Cheshire, in the West Riding, and in the East Midlands. The greatest increase of all was in Lancashire and Cheshire, and within these counties it was Merseyside together with the lower Mersey Valley, reaching inland from Merseyside as far as Warrington, that was the chief beneficiary. It is a growth, moreover, that may not yet have lost its momentum, for the percentage of numbers employed in tanning in this district increased during the inter-war period, if 1935 be compared with 1924. The increase, however, is not confined to the ports, for the East Midlands, an inland district, had also increased its percentage share of leather tanning.[1] Inland tanning is thus not only a matter of historic survival. Some of this inland tanning is due to the attraction of the market for leather, for the East Midlands is the chief seat of boot and shoe manufacture and the largest single market for leather. Some tanning, but more especially dressing, is thus attracted to its market as well as to the source of its raw materials. The tanning industry is clearly complex, it is located at many different kinds of site, and its separate parts must be distinguished and separately examined. Those branches of tanning which will be considered here are the tanning of sole leather, of upper leather, of machinery leather, of harness and saddle leather, of glove leather, and of upholstery and motor-car leather.

The tanning of sole leather is one of the heavier branches of the industry and accounted in 1935 for over three-quarters of the undressed hide leather made for sale. Some firms specialize almost entirely on this business. Of some seventy-four establishments tanning sole leather in 1938, 62 per cent were located at the ports. The largest single centre of sole-leather tanning is now Merseyside and the lower Mersey Valley, including Warrington, having 35 per cent of all establishments in 1938, and most probably a still larger percentage of output. Sole-leather tanning in London has declined. It had already declined by 1924, when the United Tanners' Association gave evidence before the Balfour Committee on Industry and Trade, and it would appear that it has continued to decline since. Other sole leather manufacturers are located at the ports of Bristol and Hull, but there are a few inland tanners of sole leather. The tanning agents employed are mostly vegetable and imported, though oak bark is

[1] If 1946 be compared with 1939, there was a further decline in London's percentage of total employment and an increase in the percentage of the North-west.

used in several country tanneries in woodland districts of Cornwall, Devon, and Kent, and the hides tanned are both imported and of British origin. Liverpool handled in the inter-war period over half of the hide imports of Great Britain, a result partly of its intimate trading relations with the countries from which the bulk of the imported hides come—South America, South Africa, Ireland, and the East. Hides are imported chiefly as liner cargoes and are rarely available in

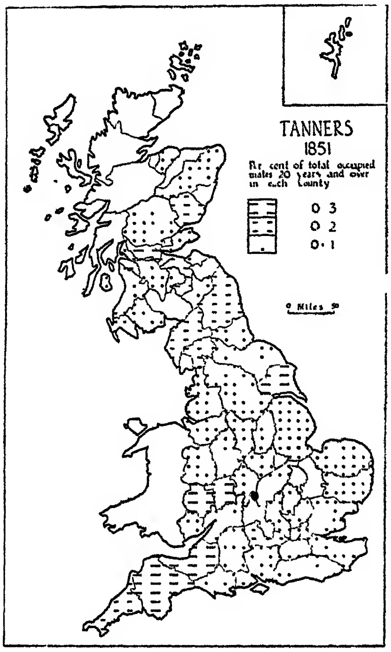

Fig. 70

TANNERS IN ENGLAND AND SCOTLAND BY COUNTIES IN 1851

Expressed as a percentage of total occupied males in all industries aged 20 years and over in each registration county. Map drawn from the 1851 Census of Population, Occupation Tables Wales is omitted

sufficient quantities to justify the chartering of a tramp specially for the purpose. They come, therefore, into the large general ports. The location of sole-leather tanning is entirely independent of the location of a boot and shoe manufacturing industry. Its soles, whether for manufacturers or for repairers, are distributed over the entire country. It is a clear case of location at the source of raw materials. But, while this is true of sole leather, it is not true to the same extent of insoling leather. This is a lighter product, being made from rolled splits, whereas sole leather is made from butts, bends, and shoulders. Only 26 per cent of the total establishments making insoling leather in

1938 were located in the ports, and of these Merseyside had 17 per cent.

Hides are also used, whether whole or split, for making mechanical belting, harness and saddlery, and upholstery. These are dressed leathers in contradistinction to the undressed leathers which the heavy tanners produce side by side with sole leather. The making up of leather into these finished articles, except machine belting, is a separate business only rarely carried on by tanners of the raw hides, but some tanners specialize in the production of undressed leather for one or other of these purposes. The tanners of machine belting are widely dispersed, but are usually located near their market, in industrial districts and port areas scattered over the country. Particularly prominent are Lancashire and Yorkshire, where leather belting is employed extensively in textile-mills. Of thirty-eight establishments in 1938 making machine belting, no less than sixteen were in Lancashire and Yorkshire, many of them in industrial villages near valley heads where abundant clean water was available. The tanning of saddle and harness leather is equally widespread and still persists in rural districts where such leather is in demand by saddlers, but it is also an activity of many tanners who make mechanical leather and is especially important in the West Midlands. The chief concern of West Midland tanning was at one time such saddlery and harness leather. It was as a tanning centre making such goods, and as an iron centre making such small iron articles as bits and stirrups, that Birmingham first became of industrial significance. Hides came from the clay lands and oak bark from the woodlands near by.[1] In the middle of the nineteenth century Birmingham, together with Walsall, made saddles and harness, but they were not to any extent tanners of the raw hides.[2] The Black Country still has some tanneries making leather for these purposes, but the demand has fallen, and they make other kinds of leather as well, particularly upholstery and motor-car leathers for the new trades of the West Midlands. The London tanneries also make large quantities of motor-car leathers. These two regions, the West Midlands and Greater London, are the chief centres of the motor trades and many tanneries within them have come to specialize on the kind of leather which the motor trades require. Of twenty-five establishments tanning hides for upholstery and motor-car work in 1938, fourteen were in Greater London and the West Midlands. Much of such specialist leather tanning, making dressed leather for a specific kind of market, is located near its market, in contrast to the initial tanning of the raw hides (the business of the sole-leather tanners), located near its raw materials. Such tanners, however, are concerned with secondary rather than with primary

[1] R. H. Kinvig, 'The North-west Midlands', in A. G. Ogilvie (ed.), *Great Britain: Essays in Regional Geography* (1928), pp. 219–20.

[2] G. C. Allen, *Industrial Development of Birmingham and the Black Country* (1929), pp. 69–70.

processes, with dressing rather than with tanning, and their location near their market is in harmony with the distinction between primary and secondary production drawn in other industries.

The tanning of skins (sheep, lamb, goat, and reptile), is a rather different business. The skins are thinner and lighter than cattle hides and are at once more easily handled and adapted to other industrial uses. Skins are employed in the boot and shoe trades for uppers, the sole leather being made from hides. A wide range of skins is involved in the production of the wide variety of upper leathers employed by the trade, for it is the upper leathers that permit variations in the style and texture of the finished shoe. Skins are employed also in glove-making and in a whole congerie of fancy leather trades. The skins employed as mechanical leather are for roller coverings for certain textile machines. Skins are thus adapted to lighter industrial purposes than the heavier hides. In his study of the American leather industries, E. M. Hoover argues that there is more waste from skins than from hides, and that, owing to this greater loss of weight, skin tanning is more subject than hide tanning to localization at the points where the skins originate.[1] It would appear, however, that the lighter weight of skins would operate counter to this loss of weight factor and the location of skin tanning in Britain does not appear to observe Hoover's diagnosis. While chemical tanning has affected sole-leather tanning to only a limited extent, it is much more common in skin tanning and, because of the small bulk of tanning agents required in the chemical processes, the tanneries are to this extent released from location at the ports where vegetable tanning agents are imported. There seems, moreover, to be much less separation in skin than in hide tanning between the pure tanners and the pure dressers. This has its implications in the localization of skin tanning, for dressing tends more readily than tanning to be located in proximity to a specific market.

British sheepskins are available in bulk in the same slaughtering centres as British hides, but they vary in their quality between north and south. The skins of Scotland, northern England, and Wales are more suitable for roller leather for machinery, while those of southern England are more suitable for shoe linings and gloves. The import of both sheep and goatskins was between the wars through London and Southampton to an even greater extent than the import of hides is through the Port of Liverpool. The distribution of skin tanning reflects these conditions. Roller leather tanning is primarily in industrial Lancashire and Yorkshire, in that part of the country whose sheepskins are suitable for the purpose and in proximity to the textile-mills and textile engineers which require roller leather. There are also

[1] Hoover, op. cit., p. 120. He is here following Link and the German evidence. Most sheepskins used in Britain are obtained by the tanners from the fellmongers and have already had their fleeces removed; this doubtless reduces the loss of weight.

many roller leather tanners in the valleys of the Welsh Border, having ample supplies of water and in contact with its raw materials, Welsh sheepskins being particularly suitable for this purpose. The tanners of glove leather are focused into southern England, and especially into South-west England, where the finished gloves are mostly made.

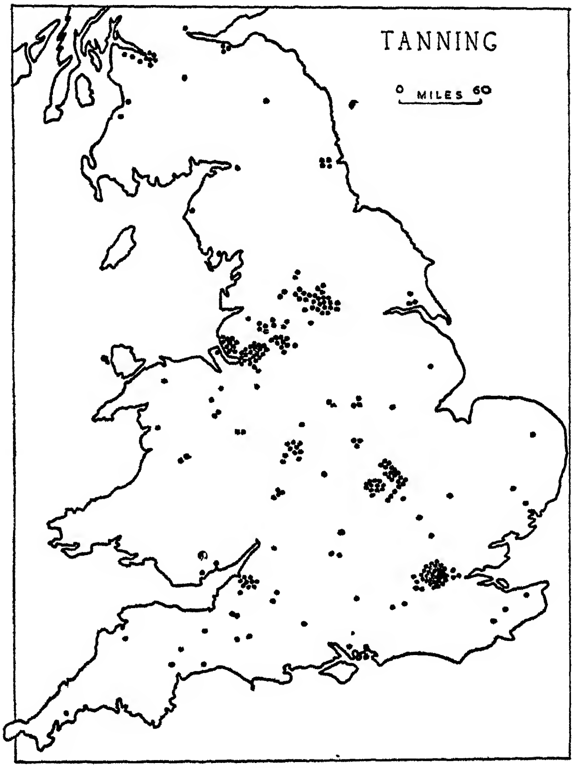

Fig. 71

TANNERIES IN GREAT BRITAIN IN 1938

Each dot represents the site of one tannery. Map drawn from data in the *Leather Trades Year Book.* Data are not available to distinguish tanneries according to size.

It is a rural tanning industry, located in part near its raw materials, for the sheepskins of southern England are especially suitable for glove-making and sheepskins are imported more extensively through southern rather than through northern ports. But it is located also near its market, an established semi-rural glove-making industry. The tanning of skins for upper shoe leather is widely dispersed. It is practised in industrial Lancashire and Yorkshire, in London, at scattered points in the South of England and in the East Midlands. Few

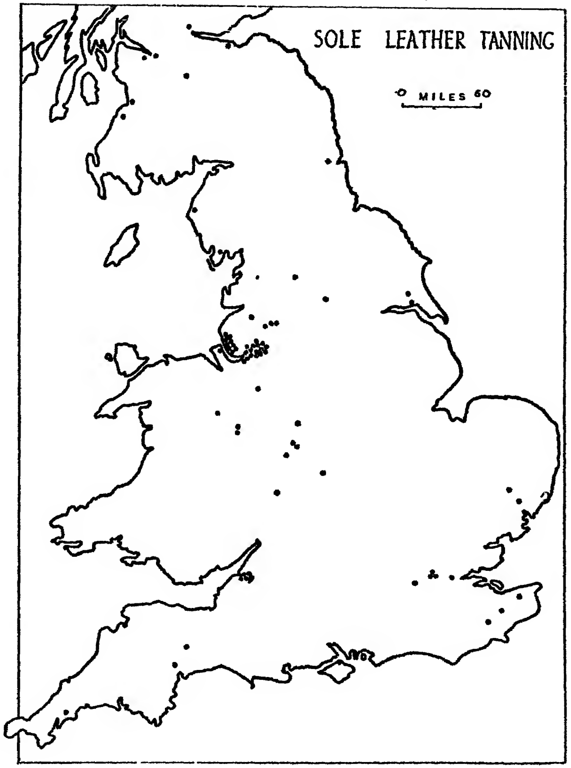

Fig. 72A

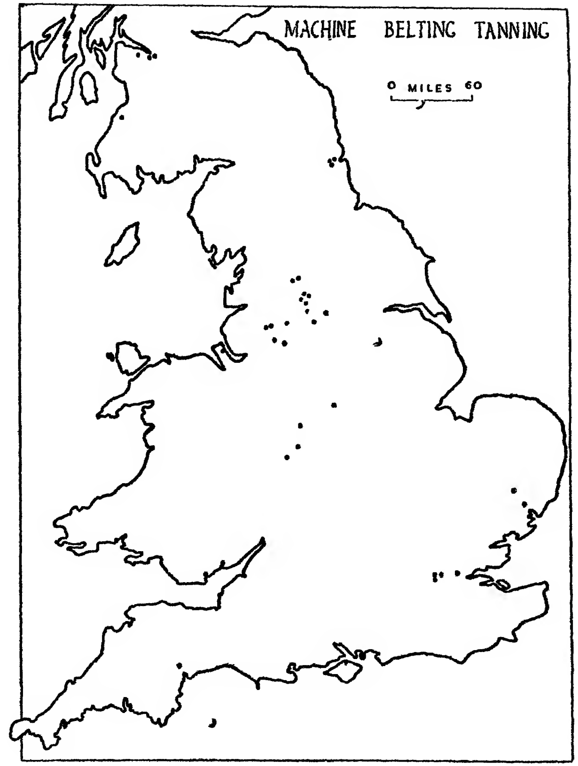

Fig. 72B

TANNERIES IN GREAT BRITAIN IN 1938 MAKING SOLE LEATHER AND LEATHER FOR MACHINE BELTING

Each dot represents the site of one tannery. Map drawn from the classified list of tanners in the *Leather Trades Year Book.* Data are not available to distinguish tanneries according to size.

tanners of upper leathers have port sites. They are found in the boot and shoe-making districts to a very much greater extent than are the sole leather tanners. The East Midlands had none of the sole leather tanners in 1938, but had 29 per cent of the tanners of upper leathers. They are not, however, focused wholly in boot and shoe manufacturing districts. It is true that the East Midlands has a greater number of such tanneries than any other *single* district, but it has not the majority, and away from the East Midlands they are widely dispersed. The wide dispersal is due in part to the combination of upper leather tanning with other forms of tanning, such as roller skins or glove leather, themselves located near their own market. But this is only a partial explanation. It may be concluded that the tanning of upper leathers displays considerable mobility with regard to both materials and markets.

Fig. 71 shows the distribution of tanneries as listed in the 1938 issue of the *Leather Trades Year Book*.[1] Each dot represents one tannery, irrespective of its size and output. The map displays the complexity of the distribution: there are urban tanneries and rural tanneries, port tanneries and inland tanneries, tanneries near their raw materials and tanneries near their markets. Fig. 72 shows the tanners of vegetable tanned sole butts, bends, bellies, and shoulders, that is, the sole leather tanners, and secondly the tanners of machine belting. The first are focused in the ports and the second are relative to their numbers more widely dispersed, though mainly in the industrial districts of Lancashire and Yorkshire.

II

BOOT AND SHOE MANUFACTURE

The manufacture of boots and shoes was originally as widely dispersed as the making up of clothes. It is classed by the Industry Tables of the Census of Population, by the Ministry of Labour, and by the Census of Production alike as a clothing industry, and with some justification in respect of distribution. Both industries persisted into the twentieth century as small-scale handicraft trades with small masters and home workers side by side with factory manufacture. Yet the boot and shoe and the textile clothing industries differ profoundly in the raw materials employed, the one being a derivative from tanning and the other from textile manufacture, and it is for this reason that in this book they are considered separately.

[1] The number of establishments in the *Leather Trades Year Book* is 265 for 1938. This does not agree with the number of establishments in the returns of the 1935 Census of Production, which total 456, or, if the manufacturers of finished articles be excluded, 373. This is made up of 90 undertaking tanning only, 144 dressing only, and 139 which are both tanners and dressers. Some of the 265 mapped no doubt employ ten persons or under and these are excluded from the Census of Production. It is probable that the *Leather Trades Year Book* list is confined to those undertaking tanning only and to those undertaking tanning as well as dressing, and that it excludes those dressing only.

The distribution of boot and shoe manufacture in 1851 displayed the conditions of an ubiquitous handicraft trade in contact with its market. Shoemakers were widely dispersed, roughly in proportion to population, but there were already some districts which stood out as having over their share. The most conspicuous was the East Midlands with 4·8 per cent of the total population but 7·6 per cent

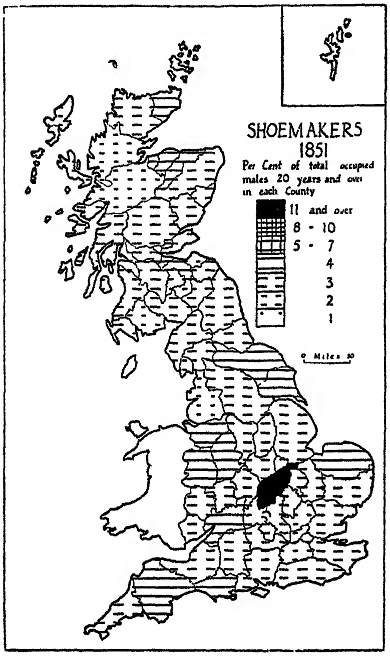

Fig. 73

SHOEMAKERS IN ENGLAND AND SCOTLAND BY COUNTIES IN 1851

Expressed as a percentage of total occupied males in all industries aged 20 years and over in each registration county. Map drawn from the 1851 Census of Population, Occupation Tables. Wales is omitted.

of the shoemakers, but other areas, in the West Midlands (Stafford) and in East England (Norfolk), had a slight excess share just becoming discernible. The amount of the excess share of these areas was, however, very small. The beginnings of specialized regional development had come more than a century previously;[1] the East Midlands had then supplied London and the export trade. But this was regional

[1] See evidence from Campbell's *London Tradesman* (1747) and the *Report* of the Select Committee on the Petitions relating to the Duty on Leather (1812–13), quoted by J. H. Clapham, *An Economic History of Modern Britain, The Early Railway Age* (1926), p. 167. See also Defoe's list of articles of apparel, which attributes shoes to Northampton (D. Defoe, *Complete English Tradesman* (1727), vol. 1, p. 330).

specialization in only an embryonic form. Everywhere the industrial unit was small. The Census of England and Wales for 1851 returned a sample of 17,665 employers, of whom only thirty-one employed a hundred men and over apiece, and of these seventeen were in the Midlands. This was very different from cotton manufacture, for example, whose sample of 1,670 employers included 411 with a hundred men and over apiece.

By 1931 the regional distribution had changed profoundly. Most areas had fewer boot and shoemakers than in 1851, a half or even a third of their number in the earlier year, and, of course, a much smaller percentage of the total in Great Britain. Some areas, such as Yorkshire and the West Midlands, had just failed to retain their percentages of 1851; others, such as East England and Lancashire, had the same percentage in 1931 as in 1851; but only one—the East Midlands—had increased both its actual numbers and its percentage share. Its numbers had grown four and a half times and its percentage share over fivefold. These returns of the Census of Population, however, mask the extent of regional specialization, for they include repairing with manufacturing, and repairing is still distributed roughly in proportion to density of population.

TABLE LXXXVIII

Distribution of Boot and Shoe Manufacture and Repair in Great Britain in 1851 and 1931

	As percentages of total in that year			
	1851		1931	
	Total population	Shoe-makers	Total population	Shoe-makers
South-east England (including Greater London)	25·3	25·6	30·1	17·5
North-east Coast	3·4	3·0	5·0	1·3
Rural North England	3·4	3·5	2·8	1·5
West Riding	6·3	5·9	7·7	4·2
Lancashire–Cheshire	11·9	10·0	13·7	10·0
West Midlands	10·2	11·7	10·1	8·6
East Midlands	4·8	7·6	5·3	39·0
East England	6·8	7·4	4·1	7·5
South-west England	8·6	8·7	4·6	2·7
Wales	5·6	5·0	5·8	1·9
Scotland	13·7	11·6	10·8	5·8
	100·0	100·0	100·0	100·0

For 1851 returns are of persons aged twenty years and over; for 1931 total population is of all ages and numbers in the boot and shoe industry are those at work aged fourteen years and over.

The statistical separation of repairing from manufacturing is attempted only by the 1935 Census of Production. The particulars are set out in Table LXXXIX, and they are discussed in the footnote to the table.

TABLE LXXXIX

Boot and Shoe Manufacturing and Repairing in 1935

	Firms employing eleven and over		Firms employing ten and under	
	Number of establishments	Number employed	Number of firms	Number employed
Manufacturers .	808	116,567	964	3,478
Repairers . .	308	6,167	8,542	17,920

These Census of Production returns, giving a total number employed of 144,132, do not tie up at all with the numbers in boot and shoemaking and repairing as given in the Census of Population, the 1931 figure being 196,072. Nor do they coincide exactly with the numbers of insured in the boot, shoe, slipper, and clog trades, as given in the July count of the Ministry of Labour, the 1935 figure being 134,300. It might be supposed that discrepancies would arise through the inclusion of retail salesmen, but the Population Census specifically excludes these, though it must be admitted that individuals who both repair used shoes and sell retail new ready-made or bespoke shoes would be very difficult to classify. Moreover, the 1931 Population Census gives 36,163 as working on their own account, and these would presumably be excluded from the Census of Production and from the returns of insured persons of the Ministry of Labour alike. If those working on their own account be deducted from 196,072, the residual figure becomes 159,909, which is much nearer in order of magnitude to the 137,840 of the Ministry of Labour 1931 count, and to the 144,942 of the 1930 Census of Production.

TABLE XC

Regional Distribution of Boot and Shoe Manufacture

Census of Production 1935			Ministry of Labour 1948 and 1950		
	Number employ'd per establishment	Percentage of numbers employ'd		Percentage of numbers employed 1948	1950
Greater London .	96	9·4	London and South-eastern .	7·9	7·6
Lancashire–Cheshire	186	9·6	Eastern . .	10·1	10·3
West Riding . .	108	2·2	Southern . .	0·4	0·2
West Midlands .	163	5·0	South-western .	4·8	4·8
East Midlands .	145	56·4	Midland . .	3·7	3·8
East England . .	275	9·9	North Midland .	55·1	54·0
Rest of England and Wales . . .	104	5·2	East and West Ridings . .	1·9	2·1
West Central Scotland . . .	189	1·1	North-western .	10·7	11·4
East Central Scotland . . .	49	0·2	Northern . .	2·5	2·6
Rest of Scotland .	120	1·0	Scotland . .	2·3	2·5
			Wales . .	0·6	0·7
	144	100·0		100·0	100·0

TABLE XCI

Trends in Regional Distribution of Boot and Shoe Manufacture, 1924–35

		Great Britain	Northampton	Leicester	Norwich	London	Bristol	Other areas
Men's:								
Thous. dozen pairs	1924	2,116	1,567	76	11	94	124	244
	1935	2,576	2,048	127	3	23	104	271
Percentages	1924	100·0	74·1	3·6	0·5	4·4	5·9	11·5
	1935	100·0	79·5	5·0	0·1	0·9	4·0	10·5
Women's.								
Thous. dozen pairs	1924	2,748	209	1,219	332	429	76	483
	1935	3,894	272	1,524	402	534	37	1,125
Percentages	1924	100·0	7·6	44·3	12·1	15·6	2·8	17·6
	1935	100·0	7·0	39·1	10·3	13·7	1·0	28·9
Children's.								
Thous. dozen pairs	1924	2,384	91	1,184	224	298	63	524
	1935	2,532	95	1,160	151	413	26	687
Percentages	1924	100·0	3·8	49·7	9·4	12·5	2·6	22·0
	1935	100·0	3·8	45·8	6·0	16·3	1·0	27·1
Average value in £ per dozen pairs, 1935:								
Men's		5·0	5·1	3·1	4·3	8·8	5·0	4·7
Women's		4·2	7·1	4·0	5·5	4·0	6·1	3·5
Children's		1·9	2·9	2·2	2·9	1·0	2·8	1·8

Abstracted or Calculated from Returns of Census Production.

The regional distribution of boot and shoe manufacturers, according to the returns of the 1935 Census of Production, is displayed in Table XC. Makers who employ ten persons and under are excluded, but such small establishments are now of little importance in manufacture, though they are paramount in repairing. This table

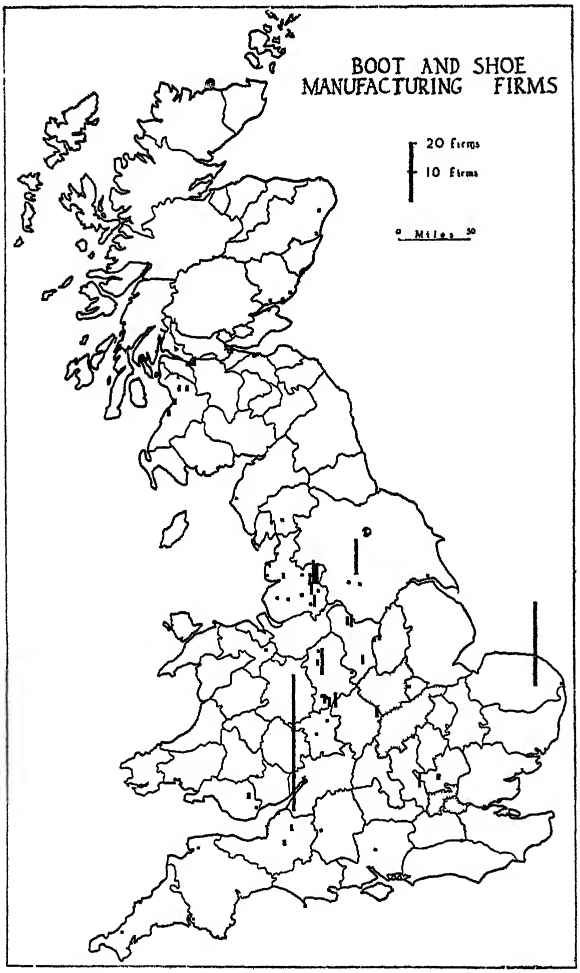

Fig. 74

BOOT AND SHOE MANUFACTURING FIRMS IN GREAT BRITAIN, EXCLUDING NORTHAMPTONSHIRE, LEICESTERSHIRE AND GREATER LONDON

The height of the column varies in proportion to the number of firms, the base of the column being placed on the site of the town or village. The excluded counties are stippled.

shows much more pronounced regional concentrations than Table LXXXVIII, which includes repairing with manufacturing. Boot and shoe manufacture is concentrated, above all, into the East Midlands, which had well over half of the total number of persons employed in 1935. This is the primary focus. Secondary centres are found in East England, Lancashire–Cheshire, and Greater London and minor centres in the West Midlands, the West Riding, the Bristol district, and Scotland. There are also isolated single factories elsewhere, such as the K Shoe Factory at Kendal and the factory of C. & J. Clark at Street in Somerset.

The regional segregation of boot and shoe manufacture, whose main outlines have just been indicated, was accompanied, indeed caused, by the growth of factories which permitted a greater volume of production at any one point, and which permitted economies of production through the use of machinery and the division of labour. Writing in 1905, Swaysland placed the beginnings of the 'present system of factory management' in 1895, but there had been factories before this date, though they were not as elaborately organized, nor were their successive processes systematized to permit a smooth balanced flow of production. The history of the Somerset firm of C. & J. Clark is very instructive in this respect.[1] After a short prelude of association with tanning, the firm began in 1825 with fellmongering and sheepskin rug-making. A few years later there was added the making of wool-lined slippers, and then of shoes. Until 1856 all work was done by hand and by out-workers at home, except leather cutting. Gradually one machine after another was adopted, some coming from America, and gradually one process after another was organized on a factory basis. It was not until the last two decades of the nineteenth century that the mechanization of the industry at Street was complete.

I propose to consider briefly each of these boot and shoe manufacturing districts in turn before discussing the trends in progress in the relative bulk of their output.

In the East Midlands, the primary focus, the two counties of Northampton and Leicester made 50·0 per cent of the boots, shoes, and slippers, in Great Britain in respect of quantity and 59·1 per cent in respect of value in 1935. The specialist manufacture of boots and shoes in the East Midlands has been attributed to the availability of cattle hides from the clay pastures of the Lias and Oxford Clay Vales, which were being increasingly laid down to grass in post-medieval times.[2] It was Northamptonshire which was first involved, and, although the county had domestic manufacture of hosiery and lace, it had few textile factories and there was labour to spare for boot

[1] *One Hundred Years' History of Shoes and Sheepskin Rugs at Street, Somerset* (1925).

[2] But see below, p. 536.

and shoe making. Indeed, domestic hosiery and lace may have developed skills which could be transferred to boot stitching. There might thus appear to be both positive and negative reasons for the concentration into the East Midlands. If the factory manufacture of boots and shoes by mechanical power had developed during the early phases of Industrial Revolution, it is conceivable that the industry would have left the East Midlands and become focused on the coalfields, as so many industries did at the time. But it developed later, and during the period when a coalfield site was no longer as essential owing to the increased fuel efficiency of power-using plants. Moreover, the amount of power required by factory boot and shoe manufacture is comparatively small and less than in British industry as a whole. This again bestows comparative independence of a coalfield site.[1] The power employed to-day is mainly electricity, and this need not be generated by coal on the factory site, but can be drawn from the grid and generated at a distance. These conditions permit the manufacture of boots and shoes to display considerable mobility of site.

The predominance of the East Midlands is more marked in respect of men's than of women's and children's footwear. In 1935 the two counties together made 84·5 per cent of the men's, 46·1 per cent of the women's, and 49·7 per cent of the children's shoes. Women's and children's shoes contain less material and are affected more by changes in taste: these factors make for greater regional mobility. The Board of Trade Working Party received evidence that the share of cost of materials to total cost varied substantially with the kind of shoe, being 73 per cent for men's boots, 60½ per cent for men's shoes, and 50 per cent for women's shoes.[2] Men's shoes are primarily the speciality of Northamptonshire, which makes very few women's and children's shoes, except of the higher qualities. Leicestershire, on the other hand, makes mainly women's and children's shoes. The two counties thus pursue markedly different specialisms. It is of advantage to the economy of manufacture and to the development of special skills, both of management and of labour, that there should be regional specialization of this kind, but it is not at first sight obvious why specialization should have taken this particular form. The most important factors in this distinction between Northampton and Leicester would appear to be, first, the earlier development of specialist boot and shoe manufacture in Northampton than in Leicester, and, second, the previous existence of hosiery manufacture in precisely the same towns and villages in Leicestershire which later developed boot and shoe manufacture. In 1851 shoemakers formed

[1] U.S.A. Census data permit the following calculations of horse-power per establishment—in 1919, 102 h.p. in all establishments and 80 h.p. in shoe factories; in 1929, 204 h.p. in all establishments and 105 h.p. in shoe factories. The number of wage-earners per factory was 31 and 146 respectively in 1919, and 42 and 153 respectively in 1929. Horse-power per person in shoe factories is thus very low.

[2] *Boots and Shoes*, Working Party Reports (1946), p. 67.

3·65 per cent of the males aged twenty years and over in Great Britain as a whole, 3·56 per cent in Leicestershire and 12·83 per cent in Northamptonshire. At that date, therefore, it may be concluded that specialist production of boots and shoes was present only in Northamptonshire. If factory organization developed first in men's shoes this would help to explain why Northampton became entrenched in the men's trade. The effect of the pre-existence of hosiery manufacture in Leicestershire is less clear, though it would presumably be easier for those accustomed to hosiery machines to make the lighter than the heavier shoes. Fig. 75 shows a striking distinction in the nature of the distribution pattern of boot and shoe manufacture in the two counties. In Northamptonshire it is a regional industry involving many places; in Leicestershire it is primarily an industry of Leicester itself and the villages around make only a small quantity of boots and shoes. The spread of the industry from Northampton to Leicester was facilitated by the practice of the machinery manufacturers of leasing machines. This has made it very much easier for a small man with a limited amount of capital to set up manufacturing on his own account. Hosiery machines and sewing machines for the making-up clothing trades may be acquired in the same way. There was, indeed, migration of workers from Northampton to Leicester at this time.

In neither Northamptonshire nor Leicestershire is boot and shoe manufacture dispersed over the whole area of the county. There are published Ministry of Labour data for July 1939 of number of insured according to exchange area. Northampton itself had 37·1 per cent of the total in the county, Kettering 18·8 per cent, Desborough 5·1 per cent, Wellingborough 10·2 per cent, Rushden 19·0 per cent, Irthlingborough 2·5 per cent, Raunds 3·6 per cent, and Wollaston 2·0 per cent.[1] These are strung along the valley of the Nene between Northampton and Raunds, and along the valley of its left-bank tributary, the Ise, which contains Kettering. The villages and factories are set back some distance beyond the flood plain of the valley floor. Not all the villages along these valleys have boot and shoe factories, but the factories are sufficient in number to create an industrial district with a degree of intensity of industrial development similar to that of Airedale, above Keighley, rather than that of a wholly industrialized valley in the heart of eastern Lancashire or West Yorkshire. The main foci have become urban districts or even municipal boroughs with an insured working population of 2,000 to 15,000. There is some metal-working and clothing, and where this is present employment in boot and shoe factories is about one-third of total insured employment in that district; elsewhere employment in boot and shoe factories is one-half to three-quarters of the total. Thus, the Rushden and Raunds exchange areas

[1] M. P. Fogarty, *Prospects of the Industrial Areas of Great Britain* (1945), p. 292.

had 73·1 and 72·4 per cent of their total insured workers in the boot and shoe industry. Many of these villages and towns have tanneries as well as boot and shoe factories but these tanneries, almost without exception, are tanners of upper leathers. The area over which

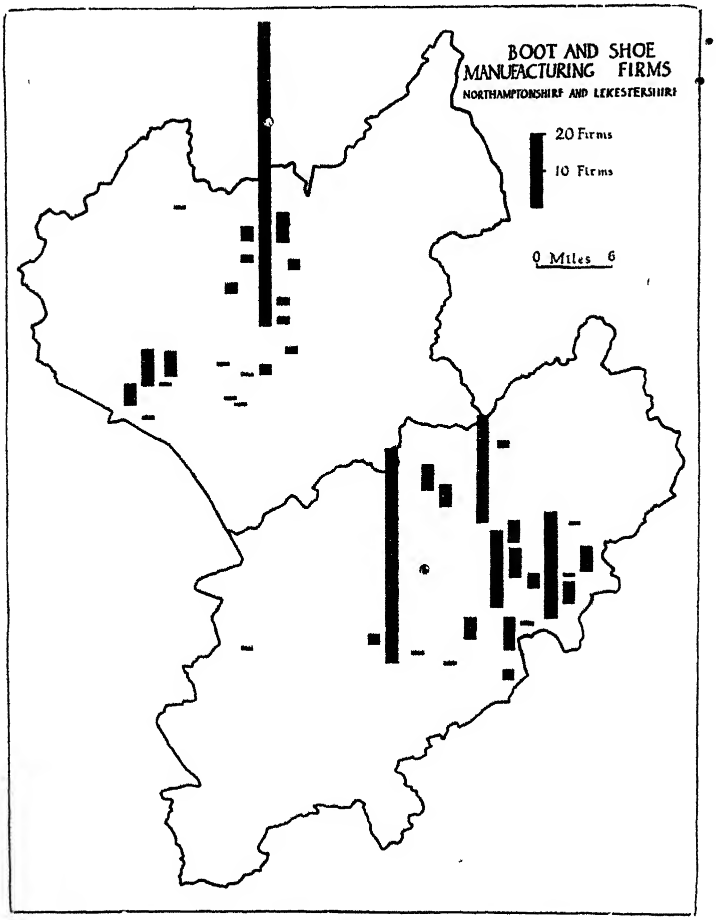

Fig. 75

BOOT AND SHOE MANUFACTURING FIRMS IN NORTHAMPTONSHIRE AND LEICESTERSHIRE

The height of the column varies in proportion to the number of firms, the base of the column being placed on the site of the town or village

the tanneries are distributed is wider than that involved in boot and shoe manufacture; it involves also that stretch of the Ouse in Buckinghamshire and Bedfordshire between Newport Pagnell and Bedford which is projected towards the Northamptonshire centres

of the industry. Only part of the leather requirements of boot and shoe manufacture are thus produced locally, for all the sole leather, at any rate, must be brought in from elsewhere. It would appear that this tanning has followed the shoe industry, or at least has developed with it side by side, rather than that shoe manufacture followed tanning. Tanning was practised to only a limited extent in the East Midlands in the middle of the nineteenth century, and it has grown greatly since that time. While tanning in Northamptonshire may thus be explained by the prior existence of a leather-using industry, it is noticeable that it was the lighter upper leather tanning and not the heavier sole leather tanning that developed thus close to its market. Most of the workers attached to the industry are described in the Occupation Tables as curriers and leather dressers rather than as tanners. This later development of tanning limits the validity of the contention that boot and shoe manufacture was located in Northamptonshire owing to the local availability of hides.[1] The problem cannot be resolved, however, until the full historical geography of the two industries in the county is worked out.

In Leicestershire the manufacture of boots and shoes is concentrated to a very large extent on Leicester itself. In 1931 Northampton had 37·2 per cent of the total in boot and shoe manufacture within the county, while Leicester had 59·8 per cent of the total within Leicestershire. It is much more of a regional industry within Northamptonshire. The Leicestershire villages and towns making boots and shoes are as widespread as those making hosiery, but not all the hosiery villages are involved. The predominance of Leicester itself may be an inheritance from the time when hosiery manufacture was leaving Leicester for the villages and when boot and shoe manufacture came in to absorb the workers unemployed by reason of that industrial migration. While labour was thus available in Leicester, it was not available to the same extent in the villages to which the hosiery manufacture was in process of migrating. Even though the numbers employed in boot and shoe manufacture are greater in Leicester than in Northampton, they contribute to a smaller extent to its total employment. The percentage of boot and shoe workers to the total in all industries in 1931 was 11·1 per cent in Leicester, but 33·9 per cent in Northampton. The remainder of the two counties had a lesser percentage, being 9·6 and 25·7 per cent in Leicestershire and Northamptonshire respectively. The number of firms in Leicester is considerably greater than in Northampton, but they are individually smaller, because of the greater variety of styles in the women's than in the men's trade, and because of the greater suitability of the small firm for the manufacture of special lines in comparatively small quantities.

[1] It may be objected that the preceding sentences refer to modern tanning and have no reference to 'pre-factory' tanning.

In both counties, but especially in Northamptonshire, boot and shoe manufacture is a village and small-town industry as well as a large-town industry. There have been differences in wage-rates between town and country which has doubtless encouraged this form of development, as it encouraged hosiery in the villages of Leicestershire. In 1906 clickers, who cut the uppers to the shapes required, earned, on time rates, 31*s*. 11*d*. in Leicester and 27*s*. 2*d*. in the rest of the county; 29*s*. 1*d*. in Northampton, 27*s*. 9*d*. in Kettering, and 26*s*. 2*d*. in the rest of the county. Lasters or riveters, who attach the uppers to the insole and outsole, earned, on time rates, 33*s*. 3*d*. in

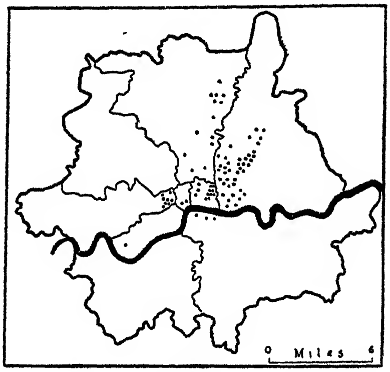

Fig. 76

BOOT AND SHOE MANUFACTURING FIRMS IN LONDON

One dot represents the site of one firm. The thick line is the Thames and the boundaries are those of postal districts.

Leicester and 29*s*. 5*d*. in the rest of the county; 31*s*. 6*d*. in Northampton, 30*s*. 9*d*. in Kettering, and 29*s*. 5*d*. in the rest of the county.[1] The quality of production in the villages and small towns is usually a grade lower than that in the county town. Thus Northampton itself makes first-grade men's shoes and the rest of the county second-grade; Leicester itself makes second-grade and the rest of the county third-grade women's shoes.

Greater London presents very different conditions. It has always had, of course, a high-class bespoke business, but it has always undertaken other work, and London makes a wide range of shoes of all qualities. Its output of men's shoes, however, has rapidly declined, and it is now virtually limited to the more expensive kinds. In 1935 London made only 0·9 per cent of the total quantity of men's shoes made in Britain in that year, but their average value (ex factory or workshop) was, per dozen pairs, £8·8, as compared

[1] Board of Trade *Enquiry into Earnings and Hours of Labour*, vol. II, Cmd. 4844 (1909). The size of the sample was 540, 119, 134, 171, 314; 134, 142, 235, 172, and 289 respectively.

with £5·0 for men's shoes in the country at large. London makes a considerably greater proportion of women's and children's shoes, but they have a value on the average below those made in the country as a whole. In the manufacture of textile clothing, London displays a precisely similar range from the highest to the lowest grades. In the income-groups of its population it presents the same range from the richest to the poorest. In the cheaper branches conditions analogous to the sweating of the late nineteenth century still persisted at the time of the *New Survey of London Life and Labour.* There is a large number of Jewish firms, particularly in the East End. The distribution of the industry within London is clearly defined. There are the Regent Street and Oxford Street shops and the bespoke trade is chiefly in the West End and Kensington. The wholesale ready-made trade is in the East End, but it is gradually shifting outwards from Stepney and Bethnal Green into Hackney and Tottenham, and even into Leyton and Walthamstow. There are a few factories and workshops in Southwark and Fulham, but the East End and North-east London provide the main focus. This radial dispersal from the centre is characteristic of many London industries, particularly those which are relatively mobile and not tied down to source of materials, and particularly those which were originally workshop or even home industries and which are now in process of transformation into mechanized factory trades. Nevertheless, the degree of mechanization and the average size of establishment were both less in London than in the country as a whole. Of the Census of Production regions, only East Central Scotland, similarly a metropolitan district, had a smaller average size of establishment in 1935.

Norwich is a specialized and isolated shoe manufacturing centre. It had already begun to develop along these lines by 1851 when shoemakers were equally as numerous as the numbers of men engaged in silk and worsted manufacture. Shoemakers formed 3·65 per cent of all males aged twenty years and over in Great Britain in 1851, but 11·02 per cent in Norwich. Augustus Petermann's map of the occupations of Great Britain drawn for the *Report* on the 1851 Census, however, does not mark boot and shoe manufacture at Norwich: the only boot and shoe manufacture which he recognized was that of Northamptonshire. Shoe manufacture in Norwich in 1931 occupied 19·6 per cent of the total industrial population. It is almost entirely concerned with women's and children's wear, and it makes shoes of better quality than Leicester, also a specialist on women's and children's shoes. The average size of its factories is larger than in any other district of Britain. Even at Norwich, however, the shoe industry is only one among several industries, and it is by no means as important in the economy of the place as it is at Northampton. Stafford is an equally isolated centre, though it has outliers at Stone and at Burton-on-Trent. The Industry Tables of

the 1931 Census do not give separate returns for boot and shoe manufacture for Stafford, but the clothing industries, as a whole, then accounted for 19·6 per cent of the total in industries in the town. The importance of the industry in the economy of the town is comparable to its importance at Norwich. Like Norwich also, Stafford concentrates its attention on the better qualities of women's shoes. Leeds and Bristol have each a boot and shoe manufacturing industry which contributed only a little less in 1931 to the total industrial structure of the place than at Norwich or Stafford. At Leeds the percentage was 14·9 and at Bristol 16·7, but at Kingswood, on the tiny Bristol coalfield, the industry employed 30·9 per cent of the total industrial population. This was a degree of specialization comparable to that of the Northamptonshire towns. Leeds, Bristol, and Kingswood, are concerned chiefly with men's boots and shoes of medium and heavy weights, that is, with workmen's boots; it is appropriate that general industrial centres like Leeds and Bristol should make these grades of footwear.

The reasons for the localization of boot and shoe manufacture at Norwich and Stafford, county towns, and at Leeds and Bristol, general industrial centres, and its absence from other places with a similar economic status and function is by no means clear. Norwich has a great market for fat cattle wintered in Norfolk fattening yards and Stafford is in the midst of the rich cattle pastures of the Middle Trent Valley; Leeds and Bristol have access to hides and skins of stock slaughtered in urban abattoirs, while Bristol is a hide and skin importing port. Norwich and Stafford, however, are devoid of tanneries. The Bristol district has approximately a dozen and the Leeds district approximately twice as many. The tanneries within Leeds itself make sole leather, insole leather or upper leather, though the other tanneries in the West Riding are concerned mainly with tanning mechanical leather. Most of the Bristol tanneries make either sole or upper leather. There thus appears to be a firm raw material basis for both the Leeds and Bristol boot manufactures. It may be that this is more important for the heavier footwear made by Leeds and Bristol than for the lighter women's and children's footwear made by Norwich and Stafford. Another boot and shoe manufacturing town similar in status to Norwich and Stafford is Kendal,[1] but there are many similar towns without any such industry. Of the large manufacturing and industrial districts, there are few, apart from the East Midlands, London, Leeds, Bristol, and Rossendale, which have boot and shoe factories. These large industrial districts had their own industrial specialisms well developed by the time of the mechanization of boot and shoe manufacture and of its transformation from a workshop to a factory trade. It was only those

[1] This is the chief town of South Westmorland, a county town in function though not in name.

places with an industrial vacuum at the time which adopted factory boot and shoe manufacture on a substantial scale. This generalization excludes Northamptonshire. Towns with decaying or decayed textile crafts were common; the list includes Norwich, Bristol, Leicester, Leeds, and Kendal. In more recent times Rossendale and Mansfield have been in this line of succession. These towns had labour accustomed to factory or workshop and they sometimes had vacant premises which could be adapted to boot and shoe manufacture. The ease with which machinery could be leased from the machine-makers permitted a new industry to start without large capital resources.

The most recent of the larger manufacturing districts to develop is Rossendale. It has grown in bulk of output, like so many new districts, by specializing in the lower grades. It had its origins in the felt slipper trade. Rossendale is an old woollen district and felt-making has persisted in and around it, despite the predominance of the cotton industry. Tab ends of felt were worked up domestically into slippers, and a felt slipper industry developed especially at a time of comparative depression in the cotton trade. It took over factory premises and adopted factory methods of manufacture in the latter decades of the nineteenth century. 'Even at the present time,' it was said in 1932, 'there is no slipper factory in Rossendale which was built in its entirety for that purpose.'[1] From felt slippers the industry developed leather slippers and women's footwear of the cheapest grades.[2] Many of the cheaper multiple stores have been supplied from Rossendale. The industry is focused on the Rossendale Valley, stretching from Rawtenstall to Bacup, but there are outliers at Bury, Rochdale, and Preston.

These are the major districts, but individual factories are widely dispersed. Villages like Eyam and Stoney Middleton, in the Peak District; seaside towns like Lytham-St. Annes, trading estates like Treforest and Hillington, depressed mining villages like Skelmersdale in Lancashire and Frizington in West Cumberland have all been involved. This wide dispersal is not unlike the wide dispersal of hosiery factories, which are also stocked, significantly enough, with machines hired or leased from the machine-makers. Men with a small amount of capital have thus been able to set up in this type of business in districts where frequently there was an untapped reservoir of female labour. Many of such factories, however, are occupied for only a short term of years.

The relative position of the major centres in bulk of output is by

[1] *An Industrial Survey of the Lancashire Area* (1932), p. 201. Many premises are described as mills and they are clearly textile mills in origin. Such mills exhibit some disadvantage in respect of lighting, for it is the older premises, with a lower standard of lighting than the newer, which were empty and available. See *Boots and Shoes*, Working Party Reports (1946), pp. 12–13.

[2] Shoe board is obtained from Sweden

no means static. There have been changes even within the compass of the inter-war period. The East Midlands increased its percentage of men's shoes between 1924 and 1935 from 77·7 per cent to 84·5 per cent, but decreased its percentage of women's and children's shoes from 51·9 to 46·1 , and from 53·5 to 49·6 respectively. It increased its share of a product which it already largely controlled and which is monopolized by Northamptonshire, the core and most stable part of the East Midland's shoe industry. It decreased its share of a product of which it had not the same monopoly and which, being lighter and made in a much greater number of styles and varieties, is more mobile. Norwich displayed a decrease in percentage share of all kinds of footwear. London lost most of its men's wear except the more expensive kinds, but it increased its share of the output of children's shoes. Bristol exhibited an all-round decrease, but it was pronounced only in respect of women's and children's shoes. The residual areas included Scotland, Leeds, Stafford, and Rossendale, as well as the widely dispersed single factories, and it is unfortunate that they were not separately distinguished. Together, they increased their percentage share of children's and particularly of women's wear; in fact, the actual output of women's shoes more than doubled. Much of this increase may be attributed to Rossendale. Taking numbers employed in shoe manufacturing and repairing together, there was an increase in Lancashire-Cheshire and a decrease in the West Riding, Scotland, and, to a small extent, in the West Midlands. The Leeds trade has declined catastrophically and Yorkshire firms have moved to the villages of Leicestershire and Northamptonshire and to Ireland. The growth of Rossendale registers the encroachment of firms producing cheaply at the lower end of the trade for the lower income elements of the population. The factor of relative value of product (ex factory) in so far as this can be analysed from the returns of the Census of Production, seems to have had some effect in determining the above regional fluctuations in percentage share of the total output of the country. The trends may be summarized as follows. If the value was above that of the country as a whole, there was a decline in percentage. If the value was slightly below the average, there was also a decline in percentage, but to a smaller degree. If the value was substantially below the average, there was an increase in percentage. These changes indicate quite clearly the erosion of the market by the cheaper grades.[1]

[1] Between 1939 and 1946 there was a general decline in employment in almost the same proportions in all districts. There were, however, slight percentage decreases in the East Midlands and slight percentage increases in the minor districts in northern and western Britain. This is a reflection of war-time dispersal and, perhaps, of current development area policy.

CHAPTER XIII

MILLING AND BAKING

THE food industries provide interesting examples of the factors affecting industrial location, of the changes consequential on the adoption of a commercial economy, of the balance of advantage between location at the point of production and location at the point of consumption, and of the variation in this balance of advantage as between primary and secondary food industries. The sample of the food industries which will be considered in this chapter are grain-milling, with bread-baking as one of its derivatives.

I

MILLING

Grain-milling has naturally and traditionally been bound up with arable farming which produced the grain to be milled. Those districts with little arable consumed little grain in medieval times. High extraction flour containing a high percentage of moisture does not keep long,[1] and milling in early times was normally at the point and time of consumption. In the corn-growing districts, areas of consumption and production were co-extensive and synonymous and the manorial mill handled the grain. But there were also town-mills which imported corn from those grain-growing districts which had a surplus of grain over the requirements of local consumption. These town-mills were thus located at the point of consumption rather than of production,[2] although they were doubtless originally established as local mills using local grain and may have continued to handle some local grain as well as that brought from a distance. The ports of the corn-growing districts shipped flour as well as grain coastwise by the eighteenth century, but they had shipped grain continuously from the Middle Ages. Dr. Willan gives examples from King's Lynn and the West Sussex ports,[3] both outlets of famous

[1] The Research Association of British Flour Millers has found that 85 per cent extraction flour will keep for nine months at 14 per cent moisture content, but for only two months at 15·5 per cent moisture content, and that 72 per cent extraction flour will keep half as long again at the same moisture contents (J. F. Lockwood, *Flour Milling* (1945), p. 191). Unless dried, British wheat has normally higher moisture contents than 14 or 15·5 per cent, and it is to be expected that in earlier times extraction was higher than at present. Flour would thus keep for only very short periods in earlier times.

[2] Thus Defoe, in describing the activities of meal-men in previous decades, says that they bought corn, wheat, and rye, within 30–40 miles of London 'which Corn they used to bring to the nearest Mills they could find to the Market and there leave it ground' (D. Defoe, *Complete English Tradesman* (1727), vol. II, pt. II, p. 37).

[3] T. S. Willan, *The English Coasting Trade, 1600–1750* (1938), pp. 127–8, 148, 154–5.

corn-growing districts. But the divorce between areas of production and areas of consumption did not become acute until the Agrarian and Industrial Revolutions, the one permitting the creation of specialist arable and specialist grass districts some of which grew no grain at all, and the other creating large aggregations of population which did not grow any of the foods they consumed. By this time all parts of Britain, arable and pastoral, industrial and commercial alike, were consuming grain, especially wheat.

When the corn-mill made flour from local grain and for local consumption, it necessarily operated on a small scale. The local mills, by custom, ground customers' grain on commission and did not buy grain to sell as flour. Grain is bulky and expensive to transport, and prior to the railway it was almost always, except in hilly districts, a water-borne cargo when carried away from the point of production. Supplies were available in bulk only at market towns in those districts producing a surplus of grain, and only at the ports, where grain was collected for export in times of plenty or imported in times of scarcity. There was overseas trade in grain in the later Middle Ages, and even in Romano-British times. Production was generally on a small scale for mechanical reasons also. Apart from hand-operated and animal-operated mills, the forms of power available were water and wind. Under British conditions these were sufficient for only small operating units and, moreover, they are variable and intermittent in their incidence, windmills being idle in still, calm anticyclonic weather and water-wheels being idle in the 'thirsty season' of summer.[1] The water-mills were limited to those districts with a sufficient flow of water and with topographical facilities for taking off river water by means of a weir or for constructing a mill dam for the storage of water and the accentuation of gradient. But great ingenuity was displayed in making the most of the topographical facilities afforded by the heads of even shallow valleys. The West Lancashire Plain and East Anglia, both low-lying, have many such ingeniously placed water-mills. There were water-mills along the Ouse in Huntingdonshire, but there were windmills in the Fens. Nevertheless, water-mills were more frequent relative to population and local grain supplies in hilly districts and their foothills.[2]

[1] The water-mill was the earlier. There were mills driven by horizontal water-wheels operated by the current of the stream; these were invariably small and mechanically simple and structural remains within Britain have persisted only in Scotland, Ireland, and the Isle of Man. There were mills driven by vertical water-wheels operated, if undershot, by the stream current and, if overshot, by a run of water from a reservoir or dam or from a conduit led off from the river by a weir or causeway. There were also a few tidal mills driven by the ebbing waters of an impounded flood tide. For the history and typology of water-mills and windmills in Britain, see R. Bennett and J. Elton, *History of Corn Milling*, vol. II (1899), which has illustrations of a large number of mills in existence at that date. Water-mills have the disadvantage of a moist situation which increases the moisture content of the wheat grain beyond the limits for satisfactory milling.

[2] The windmill does not appear to have been known in Britain until the latter

Small-scale intermittent working fitted into the rural framework of the industry. The standard staff of such rural mills, particularly of the windmills, was a miller and one or two assistants. Of the 2,394 returns from master millers for the 1851 Census of England and Wales, 403 employed no men or failed to specify a number, 664 employed a single man, and 483 two men; together these comprised some two-thirds of the sample. Those employing ten men

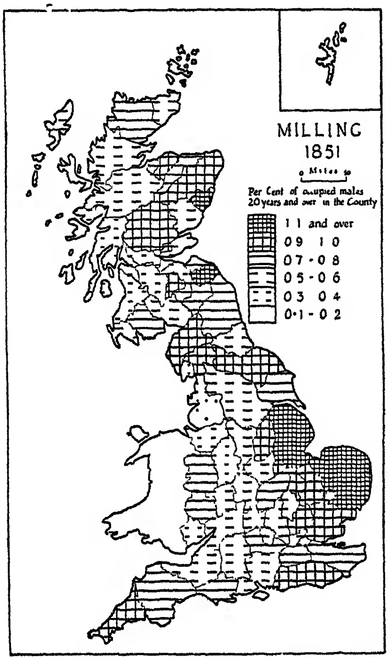

Fig. 77A

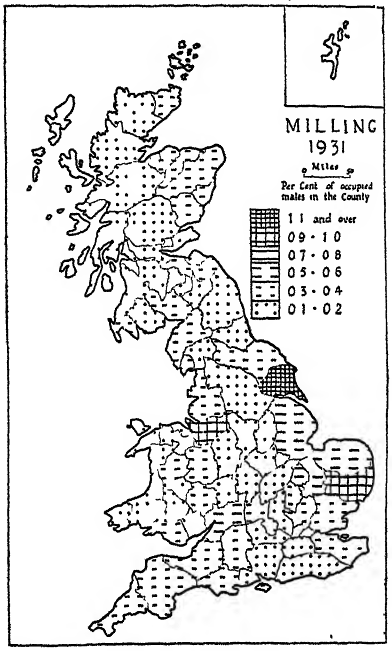

Fig. 77B

MILLING IN GREAT BRITAIN BY COUNTIES IN 1851 AND 1931

In 1851 millers expressed as a percentage of total occupied males in all industries aged 20 years and over in each registration county (excluding Wales). In 1931 males in grain milling expressed as a percentage of total males at work in all industries in each county. Maps drawn from Census returns. The scales of shading are identical in the two maps

part of the twelfth century, but it became common in the thirteenth. It had a very interesting typological evolution from the post-mill, erected on a single post supported by a tripod, and the whole of which was turned by a great beam into the wind, to the tower-mill, whose upper cap alone swivelled around into the wind automatically without human or animal labour. The largest tower-mill was at Great Yarmouth, 120 feet high (this mill was demolished about 45 years ago). The windmills were common in the plains of Britain, notably in East Anglia. The West Lancashire Plain also had many and the shells of many tower-mills still remain; some were working a quarter of a century ago. They are invariably placed on what slight eminences are available in order to catch the lightest breezes. There are some cases of water-mill and windmill existing side by side under the same management: the particular one worked at a particular time was that having greatest power available.

or over constituted only 5·1 per cent of the number of masters making returns, but they had nearly two-fifths of those employed. The small millers varied in frequency between different parts of the country. They were least numerous in London and they were most numerous in the Eastern Counties (Norfolk, Suffolk, Essex), where they constituted three-quarters of all the millers in the district. These were the extremes, but it was clearly in the more rural and least urbanized parts of the country, such as East Anglia or South-west England, where the small millers were most frequently encountered in 1851. Milling was still primarily of home-ground grain and was still based entirely on millstones. In the years 1852–3 to 1859–60 the average annual production of wheat in Great Britain was estimated by Lawes and Gilbert at 12,840,000 quarters, leaving 11,817,000 quarters available for consumption, and the net import at 3,957,000 quarters.

In the last quarter of the nineteenth century there was a revolution in the character of grain-milling, and this revolution in character had profound results on the geographical distribution of milling within Britain. There were two stages. In the 'seventies imports of wheat began to exceed home production as a result of a positive decline of home output and of a positive increase in imports. The ports and not the arable districts became the chief points of origin of the raw wheat handled by the miller. Moreover, the quantities canalized on a single point available for a single port-mill were greatly in excess of the quantities, which were not canalized but dispersed in small lots between many farmers, available for any single rural mill. Thus the port mills quickly became larger than the rural mills. Ultimately, though not immediately, imported wheat came to be not only greater in volume, but also different in nature from the soft British wheats.[1] The factors affecting the location of milling in Britain for a large section of the industry thus came to be very different from those previously in operation. This was the first stage. The second stage came when the technique of British grain-milling, particularly of wheat, was revolutionized during the last quarter of the nineteenth century. Grinding by horizontal millstones was replaced by roller-milling,[2] which made possible a much whiter and

[1] This did not happen until import, formerly of soft European wheat, came to be mainly of North American spring wheats.

[2] Millstones crushed the whole grain, and large quantities of finely pulverized bran powder were formed which could not be separated from the finely ground endosperm, the core of the grain, by mechanical sifting, on account of the identity of particle size. The by-products of millstone milling were bran, the pure husk, and middlings, a mixture of the husk and the coarser parts of the endosperm. Roller grinding splits the whole grain and scrapes the endosperm from the husk by means of rollers revolving at different speeds in place of the millstone action of crushing. The stock, as the millers describe it, is passed through the rollers many times up to seven until separation can go no further. The endosperm, which provides the white flour, constitutes on the average 85 per cent of the whole grain, so that if milling were 100 per cent efficient white flour would constitute 85 per cent of the output of the roller mill. Millers, however, can extract only 70 per cent pure white flour. If more than 70 per cent extraction is required, as by Ministry of Food Order

higher priced flour, and which led directly to the huge port-mill of to-day.

Millstone grinding has for centuries used mechanical power, wind and falling water, and the steam-engine was harnessed before 1800. There were thirteen Boulton and Watt steam-engines erected in corn-mills between 1785 and 1800.[1] Nevertheless, many small rural mills continued to use wind or water because they were cheaper, though less efficient, than steam generated by coal. The steam-mills were in the industrial districts and in the ports, where wind and falling water were either not available at all or were unsatisfactory in a built-up area. Moreover, steam-power did not achieve the full economies of which it was capable until the capacity of the mill was several times that of the small rural windmill or water-mill. Apart from the difference in power and in design of premises on a larger scale, these steam-mills employing grindstones were largely multiples of the ancient windmill and water-mill, and very large mills were not necessarily more economical to run mechanically. The steam roller-mill is inevitably a much larger unit than the steam-mill using millstones, on account of its much more elaborate mechanical equipment. It has been estimated that in 1880, when few British millers employed roller-mills, there were in the British Isles 10,000 mills[2] and 18,000 millstones grinding wheat for human consumption, and that an average pair of millstones would grind 18 cwt. of wheat or, assuming 72–75 per cent extraction, 13–13½ cwt. of flour *per day*.[3] Smaller roller-mills have a higher production cost per sack than larger roller-mills, a typical small rural roller-mill having an output of five sacks or 12½ cwt. of flour *per hour*.[4] Even this is many times the output of a pair of grindstones driven by wind or falling water. For reasons

during recent years, then bran contamination is inevitable and a pure white flour is unobtainable. By reason of the whiter flour of the roller-mill, as compared with millstone grinding, milling offals from roller-milling contain less endosperm and more bran than millers' offals from millstone grinding. Bran has fewer carbohydrates than endosperm, it contains more protein and much more fibre, and is less digestible for human consumption. Most farm animals, particularly grazing animals, can deal with more fibre than human beings and the high fibre content of millers' offals presents few difficulties in stock feeding, though it is unsuitable for certain classes of stock. The whiter flour of roller-milling means a higher fibre and protein content in the offal.

[1] J. Lord, *Capital and Steam Power*, Tables I–IV; Bennett and Elton, op. cit., vol. III (1900). Some of these, interestingly enough, were employed for pumping water back after it had operated the water-wheel in precisely the same way as the original 'fire-engine' at Boulton's Soho Works.

[2] Lockwood (op. cit., p. 282) describes the 10,000 as *millers*, but the *First Report* of the Royal Commission on Food Prices (Cmd. 2390, 1925) describes them as corn *mills* (vol. I, p. 47).

[3] The earliest steam-mill driven by a Boulton and Watt engine had an output just over twice this amount per engine, which would imply that the steam-engine drove two pairs of millstones.

[4] Lockwood (op. cit., p. 469) gives the following estimates of cost in pence per sack of flour (280 lb.): 5-sack mill, 42*d.*; 15-sack mill, 34*d.*; 30-sack mill, 31*d.*; 50-sack mill, 28*d.*; 100-sack mill, 25*d.* It will be noticed that the curve of falling costs flattens out conspicuously.

of full use of mechanical equipment and of efficient division of labour, a large roller-mill is more economical to run than a small roller-mill. As soon as large mills became mechanically economical to run, there was a great incentive to locate mills at points where supplies of wheat were available in bulk, that is, at the ports. The migration of milling to the ports was accelerated. The labour requirements of even the large port-mills, however, are small, and a 100-sack mill requires little more than 100 persons to run it continuously by shift-working through day and night. The large mills require, of course, ample quantities of power, and, if in non-coalfield areas, such power before the completion of the Grid could be obtained more readily and cheaply in the large urban and port centres than in the country, except where current can be obtained from a hydro-electric plant.

The economic contrast between small and large mill has come to have a geographical expression. The rural mill in British arable districts is commonly small: the port mill, at the gateway of Britain through which imported corn enters the country, is usually large. In 1930 it was calculated that the port centre of Merseyside had 21 mills with an average output apiece of 61 sacks per hour, while 267 mills in agricultural counties had an output apiece of just under 4 sacks per hour.[1] The contrast is so striking that the returns of the Census of Production distinguish between port and inland mills, the wheat-millers in 1935 having an average gross output per establishment of £365,000 and £80,000 and an average employment of 149 and 40 respectively. The inland mills included those in urban areas as well as those in rural. It follows that the port mills have a higher output per person employed. They are also mechanically more efficient. The reasons for difference in size are not solely differences between old and new, but are also connected with the quantities of raw grain available. For a rural miller drawing supplies from the locality, grain is available in small lots at many points, and he is compelled to rely on road transport. Of that part of the home-grown crop which is milled, by no means the whole crop ('rather more than half') is carried direct from farm to mill, the rest being accumulated by merchants and co-operative societies and frequently dispatched from the growing district for milling elsewhere.[2] The radius from which a rural mill, unless it be a very small one, collects its supplies piecemeal, is considerable, for British arable farming presents very much more variety of crops within a given area than the exporting grain-growing districts of the world; with a standard four-course rotation in a wholly arable district wheat would take up no more than a quarter of the acreage. The radius is increased by the large quantities of grain which are consumed direct by stock and never reach the miller at all. Of the

[1] G. J. S. Broomhall and J. H. Hubback, *Corn Trade Memories* (1930), p. 42.
[2] Lockwood, op. cit., p. 67.

home wheat crop in 1935, only 41·7 per cent reached the mill, and in 1934 only 35·5 per cent.[1] In the port mills the situation is entirely different. Only small quantities of home-grown grain are employed and port mills are normally dependent on imported supplies. These are available in bulk[2] and the miller need not concern himself with the handling of innumerable small parcels. When grain travels by rail, the average consignment is 6 tons for home-grown grain and 35–40 tons for imported grain. But further than this, port mills are frequently located so that grain can be discharged into the mill silo direct from the ocean-going tramp, and, when they have not ocean wharf facilities of their own, they are frequently on a canal or river bank, so that barges loaded overside from ocean-going vessels can still discharge their grain directly into the mill. The Port of Bristol at Avonmouth has separate docks for the import of grain destined for dock-side mills and for grain for rail or road transport to inland mills. Not much home-grown grain travels by water, for farms are rarely placed conveniently for water traffic: there is very little apart from the Humber, the Wash, the Fenland, East Anglia, and the Bristol Channel. Of the imported wheat, 93·9 per cent in 1935 was used for milling. The canalization of the port supplies of wheat and the diffusion of the rural wheat supplies is thus abundantly demonstrated.

Liverpool was one of the chief beneficiaries of this development of port mills. It faced North America, from which the bulk import of grain came during the nineteenth century. At the end of the eighteenth century Merseyside had some fifteen to twenty mills, mostly windmills at exposed sites on the shore or on ridge-tops, but including a few water-mills. Owing to the rapid growth of its industrial population beyond the capacity of its fields to feed it, North-west England developed during the nineteenth century an import of wheat in rapidly increasing volume. There were some thirty mills in 1845, a quarter of them driven by steam. Individual windmills and individual water-mills had a steam-engine attached, at first, no doubt, as a supplementary aid in times of calm weather or water scarcity. The tiny semi-derelict mill at Kirkby had both a water-wheel and a steam boiler installed. Many new mills were

[1] *Report* on the 1935 Census of Production, vol. III, p. 34. Estimates for previous years are 65 per cent of the control period during the 1914–18 war, and 55 to 60 per cent in 1924 (Royal Commission on Food Prices, Appendix No. XV of *First Report and Minutes of Evidence*, Q. 1142). The proportions which are milled and the proportions used for poultry feeding vary regionally. In the inter-war period 85 per cent of the wheat grown in East Anglia and the East Midlands and 85 to 90 per cent in South-west England was milled; but 40 per cent of the wheat grown in Lincolnshire, 50 per cent in Yorkshire, and 80 to 90 per cent in Northumberland was used for poultry feeding. In Lancashire about half was milled and half fed to poultry (*Report on the Marketing of Wheat, Barley, and Oats in England and Wales* (1928), p. 23). The proportions milled have doubtless increased since 1939, with the decline in the poultry population and the diversion of home-grown wheat to the mills.

[2] It was estimated in 1928 that 85 per cent of wheat imports arrived in bulk.

set up on Merseyside in the decade immediately following the Repeal of the Corn Laws in 1846: of surviving firms, two were set up in the 'fifties and three in the 'sixties. There was a further spate of mill construction on Merseyside in the last decade of the nineteenth and the first decade of the twentieth century. This followed the substitution of roller-milling for stone-milling which encouraged the growth of larger mills, themselves placed most conveniently at importing ports.[1] Such mechanical remodelling presented an opportunity for the migration of site and several firms moved to Merseyside from inland centres, particularly from the West Midlands and North Lancashire, in order to take advantage of its facilities for more economical large-scale operation. Several moved within Merseyside itself to a dock site, the most advantageous site of all. Some have been set up by milling concerns originally established in other ports, but seeking to acquire a footing in the flour market of North-west England. Conversely, a few firms of North-west England have acquired mills in the Eastern Counties. Many mills on the Cheshire side are so placed that cargoes of ocean-going tramps are discharged direct into the mill silo, and on the Lancashire side, although there are no mills within the dock estate, they are strung along the Leeds and Liverpool Canal, which carries grain barges loaded overside from ocean-going tramps in dock or mid-river.

Although the port mills are run almost wholly on imported grain and concentrate their output on baking flours for large-scale bakeries, the inland mills are not, conversely, wholly dependent on home-grown grain. The inland mills have to bear the cost of transport of imported grain from the ports, but this cost is scarcely avoidable if they are to make baking flours acceptable to the British market. In compensation home-grown grain was during the inter-war period cheaper at the mill than most imported grain. The rural mills in the wheat-growing districts are no longer at the points where the bulk of their grain supplies originate and they are thus at a disadvantage as compared with the port mills located at the point where their grain supplies enter the country. The rural mills, however, had not been at the same disadvantage before strong wheats entered so largely into the composition of baking flours.[2] Much home-grown wheat is not suitable for bread baking, the flour made from it being too weak to rise satisfactorily, and it is no doubt for this reason, as well as its higher moisture content, that it fetches lower prices than imported strong wheats.[3] It is much more suitable for making the average run of biscuit, self-raising and pastry flours, but the

[1] The capacity of Merseyside mills in 1885 was stated to be 7,000 tons per week (*First Report*, Royal Commission on Depression of Trade and Industry (1886), Appendix, p. 94).
[2] S. J. Daly, *Grain* (1928), p. 92.
[3] This lower price was partly responsible for the diversion of so much British wheat to poultry feeding.

consumption of these, though increasing, is not sufficient to absorb the whole of the home-grown grain milled. By far the greater part of the output of biscuit flours is made by country mills from wholly British wheat, and some biscuit-makers will not use flour made from Yeoman wheat, which is the British wheat most nearly adapted to baking flours of the kind now used by bakeries.[1] But these country millers also make blending flours consisting partly of soft wheats, British or imported, and partly of stronger wheats, chiefly imported, especially at the season when English wheats are difficult to obtain owing to seasonal variation in supplies. It is not unimportant that bread flours for home baking need not be as strong as bread flours employed in bakeries. This helps to explain the use of British wheats for bread flours when domestic baking was more common than it is to-day, and it also helps to explain the increased demand for imported wheat capable of being milled into stronger flours as domestic baking has declined and as more and more of the bread is baked in large-scale bakeries.

The inland mills, however, are of two kinds: there are mills in rural and mills in urban districts. The former represent a historic survival and are mostly in those regions which have continued to grow wheat. They are located at the point of production, although not the whole of the output of home wheat is, in fact, milled. The latter are located at the point of consumption. As the extraction percentage of flour from wheat, when uncontrolled, is 70–75 per cent there is some loss of bulk in the process of milling, and this, other things being equal, would encourage the location of milling at the point where wheat supplies originate; that is, the wheat-growing districts and the ports of import. But there are certain other factors which limit the universal and automatic application of Weber's loss of weight factor. The residue after flour has been extracted is not waste, but the raw material of provender milling and stock food manufacture, although its value weight for weight is less than that of flour. The availability of milling offals encourages the persistence of milling in a rural district, though the local market for these offals is not in itself a sufficient inducement for a miller to establish a business *de novo* in such a rural district if local grain supplies were not available. I have discussed this point with a country miller and his answer was unequivocal. The market for provender, however, is not limited to the country districts. Town stables and, where they remain, town shippons or cow-houses, are also an important market. The operation of this factor, therefore, would not automatically prohibit mills in industrial districts. The second factor is the close relationship between millers and bakers. This is no new development. The

[1] *Report on the Marketing of Wheat, Barley, and Oats in England and Wales*, Economic Series No. 18 (1928), Ministry of Agriculture, p. 21. For the significance of Yeoman wheat, see H. Hunter, in *Agriculture in the Twelfth Century*, Essays presented to Sir Daniel Hall (1939).

miller, by medieval custom, ground corn for individual consumers, being paid for his services in kind, and he was not allowed to buy corn for milling and subsequent sale as flour. He was thus established in centres of consumption and this type of location has persisted. But millers and bakers, though in the same localities, were then separate individuals. In more recent times, some millers have become bakers and some bakers millers. At one time it was not unusual for millers to have bakers tied to them in the same way that public-houses are tied to particular brewers. If the combined business is to be self-contained, the bakery must be larger than the mill in respect of numbers employed; it is only small flour-mills and large bakeries which can thus combine to form a single self-contained unit.[1] More often in such cases, the two parts of the combined unit do not exactly balance each other, and either flour is sold or flour is bought according to whether the flour-mill or the bakery is the dominant partner. Baking must in any case be concentrated in urban centres in close proximity to the market, and if bakeries have flour-mills attached these must also be in urban areas. It is true that there is a substantial radius of delivery of bread from an urban bakery in special cases, Liverpool bakeries delivering as far afield as Llandudno, but only a fraction of the bread baked has such a wide radius of distribution. The close association between millers and bakers, however, is breaking down and the importance of this factor in encouraging milling in large inland towns is decreasing.

The relative importance of each of these three types of site is set out in Table XCII. The persistent growth of the port mills is abundantly demonstrated. The port mills possess the more efficient plant and occupy the more efficient sites from the point of view of economic production. Their proportion of number employed is smaller than their proportion of output, and they have consequently a greater output per person employed than the inland mills. From figures of capacity referring to 1923–4, submitted by a witness to the Royal Commission on Food Prices and included in Table XC, it would appear that the inland mills then possessed a good deal of surplus capacity, for they produced less than one-third of the output on one-half of the capacity.[2] This discrepancy between capacity and output was particularly striking in the country mills, which is exactly what would be expected from their small size, their relatively archaic character, and their intermittent operation. There are differences

[1] A bakery handling 2,000 sacks of flour weekly is considered a large one: this quantity of flour represents the output of a 15- to 20-sack flour-mill under continuous day and night operation for five and a half days a week, a relatively small flour-mill.

[2] The *First Report* of the Royal Commission wrongly assumed that the port mills contributed 50 per cent of flour output as well as possessing 50 per cent of capacity. The witness, however, who had estimated the capacity of the port mills at 50 per cent recognized that they operated nearer to capacity than the inland mills and that they had more than 50 per cent of output.

between port and inland mills in the relative proportion of (a) cost of materials, fuel, and electricity, to (b) gross output; the former being relatively higher in the port than in the inland mills. The raw material is a somewhat more powerful localizing factor for the port than for the inland mills. This may be a reflection of the lower power costs of the small country mills and possibly of the somewhat lower cost of home-grown wheat, but it also reflects the more economical use of labour in the port mills shown in a higher net output per person.

TABLE XCII

Relative Importance of Port and Inland Mills

	Port mills	Country mills	Mills in Inland towns	Inland mills not separately distinguished	All Mills
Percentage of flour output:					
1912	62·5	—	—	37·5	100·0
1924	70·2	18·1	11·7	—	100·0
1930	71·3	—	—	28·7	100·0
1935	76·2	—	—	23·8	100·0
Percentage of numbers employed:					
1930	67·0	—	—	33·0	100·0
1935	70·1	—	—	29·9	100·0
Net output per person employed in £ per annum:					
1930	384	—	—	348	372
1935	436	—	—	396	424
Cost of materials, fuel, and electricity as per cent of gross output:					
1930	87·2	—	—	85·6	86·6
1935	82·2	—	—	79·9	81·6
Milling capacity:					
1923–4.	50·0	33·0	17·0	—	100·0

From *Reports* on the Census of Production. Milling capacity from the *First Report* of Royal Commission on Food Prices (1925).

The distribution of roller flour mills over Great Britain is shown in Figs. 78–9, which have been constructed from the lists drawn up by J. M. Smith. The wide dispersion of flour-milling is amply demonstrated, but it will at once be noticed that the port mills stand out sharply from the inland mills in two respects, firstly because of their conspicuously greater size and secondly because of their much stronger nucleation. Both are functions of the canalization of wheat supplies on the large importing ports on the Thames, Bristol Channel,

further that the rural mills are in the wheat-growing districts of the country and that they die away towards the west and north. Rural flour mills were once more widely dispersed as wheat-growing was more widely dispersed and former grindstone mills remain not only within the present milling districts but also beyond them. Some of these have been converted to provender mills, some are merely empty shells. They were, of course, much smaller than the roller-mills in Figs. 78 and 79. The larger country millers have a market town site for these permit minor concentrations of supplies and of these many are at the railway station or on the station road. Of the inland mills, rural and urban alike, the majority are without access to water transport and those which have such access lie mainly in the Midlands. But a canal-site, while of great value as a channel for imported grain whose supplies are canalized, is of only limited value as a channel for the receipt of home-grown grain whose supplies are widely dispersed. Of the port mills, there are very few which have no direct access to water transport. They are not merely at the ports, but in direct physical contact with ocean-going or, at least, barge traffic. All the large general ports are involved, particularly those with a large import trade. But some coal exporting ports also have roller flour mills and they import their wheat as return cargoes in colliers exporting coal. Wheat is a tramp cargo and tramps come into the large general ports and coal-exporting ports alike. The pattern of roller flour mills over the face of Britain is thus composite: it has old and new, inland and port sites with access to rail, road and water, either singly or in combination. In addition to the roller flour mills there are innumerable wind and water mills, mostly now in ruins, and where they survive intact they are primarily provender grinders for the local stock population.

The distribution of flour-mills within Great Britain is of interest not only in respect of type of site, but also in respect of regional distribution as between the different quarters of the country. The statistical material of the Censuses of Production and of Population refers, however, to grain-milling in its total sense; that is, including other grains as well as wheat. Mills handling other grains are smaller and include fewer port mills than those producing wheat flour.[1] It

[1] The 1935 Census of Production returned 277 mills handling wheat and 225 handling other grains, in each case of mills employing over ten persons. But, while the wheat-flour mills employed 22,885, the other grain mills employed only 7,250 persons. There were many smaller mills employing ten persons and under, and these were relatively more numerous in milling grains other than wheat. Such mills in 1935 employing ten and under made only 1·7 per cent of the total value of flour produced, but 30·8 per cent, 42·0 per cent, and 19·1 per cent of the output of oats, barley, and maize products respectively. In relation to total output, therefore, the small mills are of very little importance in wheat-flour milling, but they are of very considerable importance in the milling of other grains. The mills handling

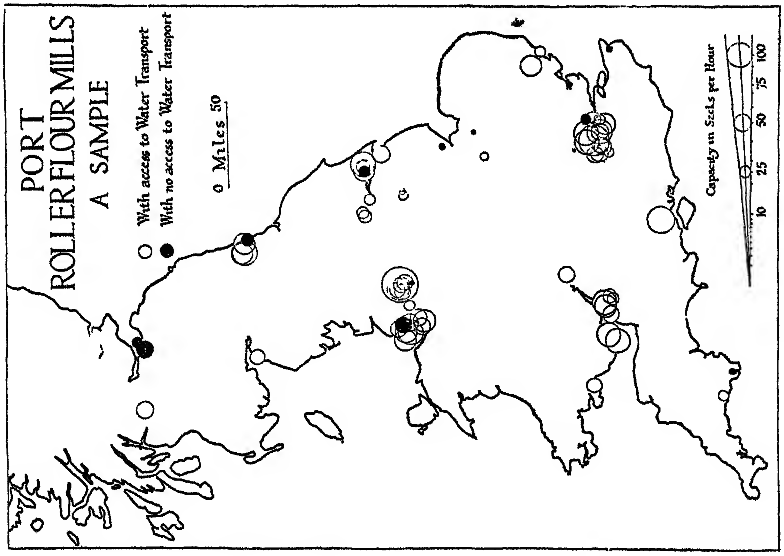

Fig. 79A

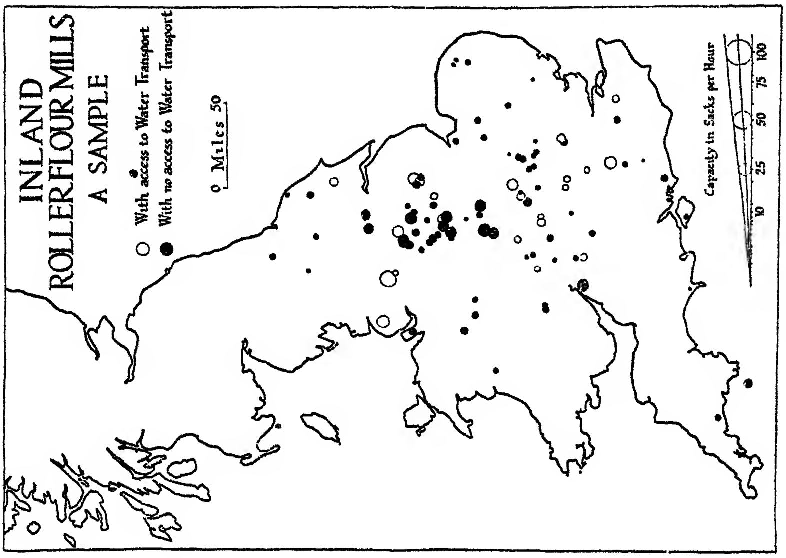

Fig. 79B

FLOUR MILLS IN TWO GROUPS

Constructed from lists drawn up by J. M. Smith. Map A is of port mills and B of inland mills, *being a sample in each case* Centre of each circle is placed on site of mill: overlapping circles are unavoidable where mills lie close together.

is necessary to bear these differences in mind when considering the regional distribution of grain-milling as given in Table XCIII.

Table XCIII gives the regional distribution of grain-milling from two sources: the Censuses of Production for 1924, 1930, and 1935, and the Censuses of Population for 1851 and 1931. The latter material displays the long-term trends and registers the regional expression of the migration to the ports which has been analysed above. The year 1851 was considerably anterior to the adoption of roller-milling in Britain and, although the import of grain was rapidly increasing, it had not yet attained the dimensions that it reached later in the century: the year 1931 was long subsequent to both these changes. The marked increase in milling in South-east England, Lancashire–Cheshire, and rural North England displays the migration to the ports of London, Liverpool, and Hull respectively. The marked decline in milling in the East Midlands, East England, South-west England, Wales, and Scotland registers the decline of rural milling. It is instructive to compare the regional distribution of milling with that of total population, and columns have been added to Table XCIII to facilitate this comparison. Milling has traditionally been widely dispersed in areas of consumption as well as in areas of production. The diffusion of milling in proportion to population was less marked in 1931 than in 1851, and there was therefore a greater degree of regional concentration in 1931. The regions with a conspicuously greater share of milling than of total population were in order, in 1851, East England, rural North England, South-west England, and the East Midlands; and, in 1931, East England, rural North England, and Lancashire–Cheshire. The regions with a conspicuously smaller share were, again in order, in 1851, Lancashire–Cheshire, South-east England; and, in 1931, the North-east Coast, the West Riding, the East Midlands, South-east England, Scotland, and the West Midlands. The excess share of East England and of rural North England is constant, a function of the grain-growing of the eastern side of England, reinforced by the port-milling of Hull. The deficit of South-east England is equally constant, a function of the size of Greater London, despite the port-milling of Thames-side, and a result of the availability of flour from the country mills of East Anglia. Lancashire–Cheshire completely changed its status, having a large deficit of milling in 1851, but an

other grains, moreover, have a rather different balance of distribution as between port and inland sites. In 1935 the port mills were responsible for 76·2 per cent of the wheat flour, 73·5 per cent of the maize products, 48·4 per cent of the oats products, and 63·9 per cent of the barley products of those mills employing over ten persons. Only maize, an imported grain, is milled at the ports to the same extent as wheat. Moreover, a large share of the milling of oats and barley is in the hands of mills employing ten persons and under, and these tiny mills are mostly rural in site. It is justifiable to conclude that a much greater proportion of the oats and barley than of the wheat is handled by small rural mills removed from the ports. This is especially true of oats.

TABLE XCIII

Regional Distribution of Grain-milling

A. Census of Production

	Percentage of numbers employed			Percentage of gross output		
	1924	1930	1935	1924	1930	1935
Greater London	16·0	19·3	19·8	17·9	19·3	21·2
Lancashire–Cheshire	23·8	23·9	23·7	25·1	28·0	25·7
West Riding	5·9	4·2	5·4	5·9	4·2	5·3
North-east Coast	3·8	4·1	2·9	4·3	4·4	3·2
West Midlands	3·2	2·3	2·8	2·8	1·9	2·3
East Midlands			1·7			1·6
Welsh Border			6·0			6·8
South-east England			4·7			3·7
South-west England	31·0	31·4	3·1	29·1	28·5	2·8
East England						
Cumberland–Westmorland			17·1			15·1
South Wales						
Rest of Wales	8·4	6·7	4·9	7·8	6·1	4·7
West Central Scotland	3·0	3·2	3·3	3·3	3·1	3·2
East Central Scotland			2·9			3·2
South Scotland	4·9	4·9	1·0	3·8	4·5	0·7
North Scotland			0·7			0·5
	100·0	100·0	100·0	100·0	100·0	100·0

B. Census of Population

	Grain-milling				Total population	
	Actual Numbers		Percentages		Percentages	
	1851	1931	1851	1931	1851	1931
South-east England	5,844	8,015	19·3	23·7	25·3	30·1
North-east Coast	1,185	1,009	3·9	3·0	3·4	5·1
Rural North England	1,668	2,143	5·5	6·3	3·4	2·8
West Riding	1,749	1,664	5·8	4·9	6·3	7·7
Lancashire–Cheshire	1,676	7,398	5·6	21·9	11·9	13·7
West Midlands	2,877	2,696	9·5	8·0	10·2	10·1
East Midlands	1,823	1,215	6·0	3·6	4·8	5·3
East England	4,220	3,072	14·0	9·1	6·8	4·0
South-west England	3,383	1,807	11·2	5·3	8·6	4·6
Wales	1,988	1,950	6·6	5·8	5·6	5·8
Scotland	3,806	2,855	12·6	8·4	13·7	10·8
	30,219	33,824	100·0	100·0	100·0	100·0

The returns for 1851 are of millers (males), aged twenty years and over, for 1931 those at work in grain-milling (males), aged fourteen years and over. The regions are those as defined for the purposes of the 1931 Census.

equally large excess in 1931, an eloquent witness of the transformation effected by the development of port-milling. Most of the industrial districts, with the exception of Lancashire–Cheshire, had substantial deficits in 1931, but in 1851 had either only a small deficit or even a slight excess. This does not necessarily mean that the milling industries of the industrial districts (and the rural areas adjacent) have positively declined, though that has happened in some cases, but that the growth in their total population has not been matched by a growth in their milling industries. In rural East England there has been a positive decline in country milling, but rural population has also fallen and the excess share of milling has been maintained.

There is a substantial trade in flour from the areas of excess to the areas of deficit output, but, as flour is a bulky commodity, it is not transported indiscriminately from one extremity of the country to the other. It is shipped long distances coastwise, but inland only over relatively restricted distances within that particular quarter of the country. Scotland, indeed, during the inter-war period, obtained a large proportion of its deficit by means of flour imports direct from North America. The Royal Commission on Food Prices estimated imports of flour at 'probably' 40 per cent of Scottish consumption, but at only 12 per cent of consumption for the United Kingdom as a whole.[1] Scotland has a smaller proportion of the wheat import than it has of the total population, and it uses little home-grown wheat. The Scottish market is known to prefer a stronger baking flour than the English market, and this requirement American flour satisfies. The price of port-milled flour varies according to zone and with distance from the port mill:[2] it follows that inland centres with a deficit of output in relation to consumption are supplied from the nearest port. The country is thus naturally divided into segments or quarters, each being tributary to a particular port. Some of the larger milling concerns with a business originally developed in a particular part of Britain have set up mills in other parts rather than expand their original premises and develop cross-country rail traffic from a single huge milling plant. The cost of transporting flour by rail is such that this is the most economic procedure. Such acquisition of mills in several port-milling centres is the declared policy of three groups of millers responsible in 1925 for 'practically 35 per cent of the flour consumed in the United Kingdom.'[3] The port mills of South

[1] *First Report*, Royal Commission on Food Prices, vol. I, pp. 48 and 54. Also *Minutes of Evidence*, QQ. 1019–20 and 1081.

[2] *First Report*, Royal Commission on Food Prices, vol. I, p. 52.

[3] Royal Commission on Food Prices, Appendix LII. Three groups of millers by 1930 were producing an estimated proportion of 62·5 per cent of the flour of the country, according to A. H. Hurst, *The Bread of Britain* (1930), p. 28. H. Leak and A. Maizels, 'The Structure of British Industry', *Journal Royal Statistical Society*, vol. CVIII (1945), attribute 61 per cent of the gross output of the port mills to the three largest units. These calculations were based on the data collected for the 1935 Census.

Britain fall into the following four groups: (*a*) Thames-side; (*b*) Avonmouth, Gloucester, and the South Wales Coast; (*c*) Merseyside and Manchester; (*d*) Hull and Newcastle-on-Tyne. The proportions of the wheat import handled by the major ports in the years 1935–8 was as follows—London, 25·9 per cent; Liverpool, 19·4; Manchester, 10·8; Hull, 15·0; North-east Coast, 2·8; Bristol, 7·4; Gloucester, 1·8; South Wales, 4·7; Glasgow, 3·1; and Leith, 3·0. Some flour is shipped coastwise. The radius of inland distribution from any one of these four groups[1] is dependent largely on railway rates, as the competition between Merseyside and Bristol for the West Midlands traffic has shown.[2] Before the development of roller-milling on Merseyside and the consequential expansion of flour production in North-west England, Manchester bakers used much flour milled in Eastern England.[3] Lancashire-Cheshire was then an area of marked deficit. It is the port-milled flour which is carried substantial distances within its proper quarter of the country. The country mills distribute their baking flours over a much smaller radius—20–25 miles—though their biscuit flours are distributed more widely. The inland town millers serve primarily local markets alone.[4]

II

BREAD BAKING

Bread baking is derived from grain-milling and prepares grain in its final consumable form. It is for this reason in close contact with the consumer, and is in especially close contact because of the short period during which bread will keep fresh and palatable. It is in any case a relatively mobile industry, on all tests, weight of materials, value of product per ton, cost of materials as percentage of gross output. There is, moreover, no loss but a positive gain in

[1] The grain and flour trades of the Port of Liverpool were stated to have business connexions within a radius of 120 miles in 1885 (*First Report*, Royal Commission on Depression of Trade and Industry (1886), p. 93).

[2] Merseyside millers have frequently complained of rate discrimination in favour of Bristol (amounting to 4*s*. in 1890 and 2*s*. in 1928), but the Railway and Canal Commission would not rectify the inequality of the rates as it was held to be in the national interest to keep the port of Bristol in being, and it was held that the weaker port required some protection against the stronger. The lower rail rate to the Midlands from the Severn Estuary is, in fact, to be attributed largely to the greater effectiveness of canal competition on that route.

[3] Broomhall and Hubback, op. cit., p. 105.

[4] The regional percentage distribution of numbers employed in grain milling differed little in 1946 as compared with 1939. There were, however, some significant changes, slight though they may have been. Those regions of the Ministry of Labour with a lesser percentage of insured employed were the South-east, North-west, South-west, East and West Ridings (which contain between them London, Merseyside, Bristol and Hull). They had had 58·9 per cent in 1939, but 53·0 per cent in 1946. There was a lesser import of wheat, and especially of maize, in 1946 as compared with 1938, being 67 and 102 million cwt. respectively for wheat and 2 and 58 million cwt. respectively for maize. The port milling centres would suffer from these import restrictions and the inland mills would benefit from increased home grain production.

weight in the course of manufacture.[1] The extent to which the distribution of baking is coincident with the distribution of the total population will be considered shortly. Indeed, baking has long been, and in some places still is, a household industry performed not merely in the place, but at the very point of consumption. It will be interesting to consider household baking first.

This may have been universal in early times in country districts among farmers growing their own grain and practising a subsistence form of farming at a low level of comfort. In a township of scattered hamlets and farms any other method of bread baking would have been impracticable, but in a large nucleated village it was possible for a specialist baker to supply a whole village with its bread, or, alternatively, for communal ovens to be set up where villagers could bake their own bread. There may have been some village bakers in the nucleated villages of the English Plain, but there were few in the North of England with its fewer nucleated villages and its more widely dispersed population. There was a further reason why household baking became less common in the English Plain than in the north and west, but it did not begin to operate in full intensity until the post-medieval period. This was the growing scarcity of firewood to heat the domestic oven in the English Plain and, in contrast, the maintenance of supplies of domestic fuel on the coalfields and in the scantily peopled hill areas with their wooded valley sides.[2] But it was in the towns that the specialist bakers developed earliest and became most numerous, for the towns provided the aggregations of population without which a specialist baker could not function and they provided an economy accustomed to specialist craftsmen. Not all bakers, however, were full-time practitioners, and there were some women bakers, as there are confectioners to-day, who practised baking for a livelihood, alongside the rearing of a family.[3] The baker was long regarded in custom as a converter of flour into bread, with a fixed commission for his services, and his craft was hedged around with regulations.[4] The capitalist miller did not begin to become common until the seventeenth century. The emergence of capitalist millers making flour for sale altered commercial practice[5] and was

[1] See below p. 565.

[2] Prof. P. Barrett Whale has independently made precisely the same point to me in reference to domestic baking in South Wales.

[3] *Liverpool Town Books*, vol. II (1935), pp. 237–8.

[4] S. and B. Webb, 'The Assize of Bread', *Economic Journal*, vol. XIV (1904), p. 201; C. R. Fay, *The Corn Laws and Social England* (1932), p. 45. The Assize of Bread fixed the weight of the loaf and its quality, the weight varying with the price of wheat. It varied with the price of wheat rather than with the price of flour, for the miller was regarded as a converter of grain into flour for customers, whether individual householders or bakers, and entitled only, like the baker, to a commission for his services.

[5] Defoe has an instructive passage on this very development. '. . . the Bakers in London, and the parts adjacent, go to the Markets themselves, and have cut out the Shopkeeping Meal-men; . . . and as the Bakers have cut out the Meal-shops in London, so the Millers have cut out the Meal-men in the Country; and whereas

largely responsible for changes in the composition of the loaf. Bakers formerly bought corn for the millers to grind on commission and baked a sort of wholemeal loaf from the flour milled under these conditions.[1] But with the growing practice of making flour for sale, it became of advantage to the millers to sort their flours into more varied grades than hitherto, and to put on the market both whiter and coarser flours than had previously been consumed. The demand for white flour, at first among the wealthier classes in London, but gradually spreading in wider and wider circles to encompass ultimately the whole population of Britain, implied the rejection of the coarser flours for bread baking formerly used for this purpose and the transfer of the coarser residues to stock feeding.

Domestic baking has persisted only in the North of England, and even here it rapidly declined during the inter-war period. In Manchester, in 1813, half the households made their own bread, though they had it baked in the public ovens.[2] The ratio of bakers to total population varied widely at the time of the 1851 Census, from 1 in 229 in London to 1 in 1,174 in the West Riding of Yorkshire. It may be inferred that household baking persisted in strength in the West Riding. Those parts with the least domestic baking, on this evidence, were, besides London, the South-east and South Midland counties. The degree to which household baking persisted increased radially outwards to culminate in Cornwall, Wales, and Yorkshire. In these districts where domestic baking was most pronounced, the bakers who were returned as such were more frequently women than men. Domestic baking was not so pronounced in the northern counties nor in North-west England, though it was still higher than in the West and North Midlands, which in turn had more domestic baking than the Home Counties. In Scotland the metropolitan centre of Edinburgh had, relative to its population, as many bakers as London, but the remote Highland counties had as few as those English counties where domestic baking persisted in strength. In 1924 it was still possible to pick out Yorkshire and the North-east Coast and, to a lesser extent, Lancashire–Cheshire, as areas where domestic baking survived, the supply of bakers' bread per head of population being one-third in Yorkshire and two-thirds in Lancashire–Cheshire of that in the remainder of the country.[3] In the North of England, at any rate away from the large cities, and as late as the early

they formerly only ground the Corn for the Meal-men, they now scorn that trade, buy the Corn, and grind it for themselves; so the Baker goes to the Miller for his Meal and the Miller goes to the Market for the Corn' (D. Defoe, *The Complete English Tradesman* (1727), vol. II, pt. II, p. 37).

[1] There were three kinds of bread: white, wheaten, and household, in order of fineness. The first and second were doubtless from wheat, but the third was brown bread in the sixteenth century and included some rye and perhaps barley, as well as wheat (W. J. Ashley, *The Bread of Our Forefathers* (1928), pp. 151–3).

[2] Fay, op. cit., p. 52.

[3] *Report*, 1924 Census of Production, pt. II, p. 52.

decades of this century, baking day had a fixed place in the weekly domestic calendar. This persistence of domestic baking was due, in addition to the historical circumstances indicated above, to the housewife's pride in her housecraft and a consequential disdain of the quality of 'shop bread'. When such housewives ceased domestic manufacture, they tended to buy from a small baker making and

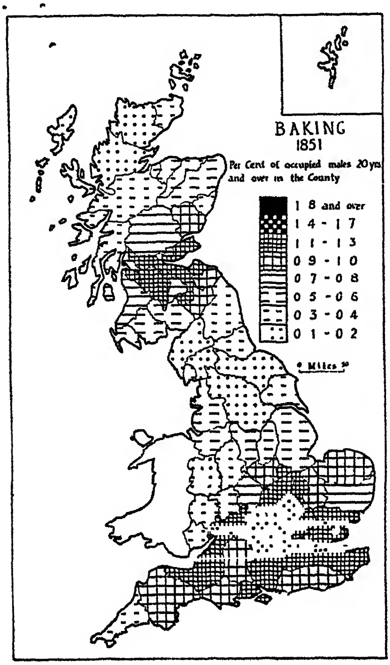

Fig. 80A

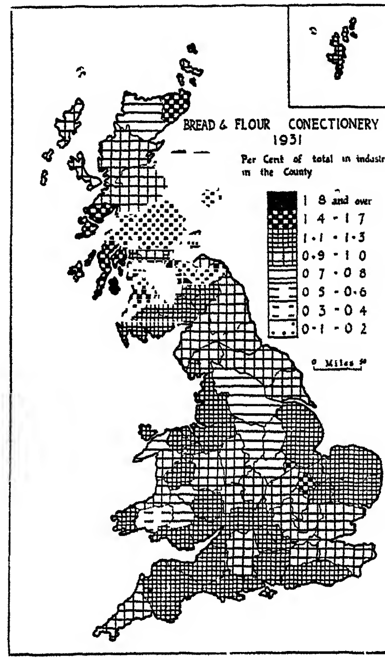

Fig. 80B

BAKING IN GREAT BRITAIN BY COUNTIES IN 1851 AND 1931

In 1851 bakers expressed as a percentage of total occupied males in all industries aged 20 years and over in each registration county (excluding Wales). In 1931 males and females in the bread and flour confectionery industry expressed as a percentage of total males and females at work in all industries in each county. The shading scales are identical in the two maps. Maps drawn from Census returns. The completeness of the revolution between the two dates is most impressive.

retailing his own bread, rather than from a large wholesale factory baker.

As a specialist industry of the present day, baking presents a great range of bakeries of very varying sizes, from the small producer-retailer selling bread over the counter or delivering it himself, to the large wholesaler distributing bread to retail shops within a radius of 100 miles. Baking has this varied economic structure very largely because of the high proportion that distribution costs contribute

towards total expenses. The Royal Commission on Food Prices gave figures to show that baking expenses, that is the conversion of flour into bread, were little more than costs of distribution of the finished loaf.[1] The factory bakery makes its bread more cheaply because of its mass production methods, but this larger output has to be distributed over a wider area than that of the small baker and distribution costs are consequently higher. These two conditions balance each other sufficiently nearly to permit competition on roughly equal terms between large and small concerns.[2] It is interesting to investigate the extent to which these large and small concerns vary in relative frequency in different parts of the country.

There was only a limited variation in size of the bakery unit at the time of the 1851 Census. In England and Wales returns were obtained from some 5,203 employers, of which 1,785 were single proprietors or failed to specify the number they employed, and of which 1,692 employed only one man. There were only twenty-seven employing ten men or over, two of these each employing over a hundred men. The average number employed by all who made a specific return was only 2·02. Baking was still primarily a small-scale business. This was true of all regions in England and Wales. Even in London, where the proportion of the businesses employing only one man was less than elsewhere in the country, the average number employed worked out at only 2·12 men. The 1931 Census returns do not permit a similar calculation, but it is possible to calculate a ratio between the category 'employers, directors, managers' (less branch managers and managers of subsidiary departments) and the category 'operatives'. For London the ratio was 1 in 12·4, but for the county boroughs of the West Riding 1 in 5·9 and for the rest of the West Riding 1 in 5·2. For England and Wales it was 1 in 7·3, for Liverpool 1 in 14·7, for Manchester 1 in 9·8, for Burnley 1 in 4·0, for Oldham 1 in 4·4, for Preston 1 in 3·2, for rural Norfolk 1 in 3·6, for rural Dorset 1 in 4·3, and for Westmorland 1 in 3·9. From these random samples it would appear that bakeries are largest in the large conurbations and smallest in the country, and that bakeries in the small and medium-sized towns tend to approximate in size more closely to those of the country districts than to those of the large towns. These differences are more pronounced than the regional differences. The regional returns of the 1935 Census of Production involved only three-fifths of the numbers employed, the rest being in firms employing ten persons and under. For what they are worth,

[1] *First Report*, p. 22 and Annex I, pp. 154–5. For a mixture of 389 lb. of wheat flour, baking costs were calculated at 10*s.* and distribution costs at 9*s.* 6*d.*

[2] D. Braithwaite and S. P. Dobbs, *The Distribution of Consumable Goods* (1932). An indication of these differences is afforded by some sample returns made by a London baker to the Royal Commission in 1924. For four wholesale factories baking expenses per sack were 8*s.* 2*d.*, costs of distribution and sale, 14*s.* 1*d.*; for fourteen retail bakers, 10*s.* 6*d.* and 6*s.* 10½*d.* respectively. The wholesale factories, buying their flour in bulk, obtained it more cheaply.

these gave an average per establishment ranging between 74 in West Central Scotland to 23 in Cumberland–Westmorland and 24 in North Wales, but only 5 out of 17 regions lay outside the 30–50 range.

Despite the general decline of household baking and the growth of the factory bakery, the ratio between those in the bread and flour confectionery trades and the total population is by no means uniform over the country. The variations between large regions are small, but they are more substantial between individual towns. The Lancashire weaving towns had in 1931 an extraordinarily large number in the bread and confectionery trades: the ratio for England and Wales, as a whole, was 1 in 242, but in Nelson 1 in 86, in Darwen 1 in 105, in Accrington 1 in 110, in Colne 1 in 121, in Blackburn 1 in 126, and in Burnley 1 in 138. The Lancashire spinning towns had intermediate, though overlapping, ratios: in Chorley 1 in 123, in Ashton-under-Lyne 1 in 128, in Bolton 1 in 154, in Rochdale 1 in 158, in Oldham 1 in 177, and in Leigh 1 in 224. The Lancashire mining towns had ratios ranging above and below that for England and Wales, and these may be regarded as conforming to average British conditions. The large cities of Manchester and Liverpool had a greater proportion of bakers than England and Wales, but this was due partly to the circumstance that they made bread for a wider area than the city alone. The seaside towns of Southport, Lytham–St. Annes, Blackpool, and Morecambe–Heysham had proportions of bakers almost as high as in the Lancashire weaving towns. Suburban areas, such as Sale, near Manchester, or Bebington, near Birkenhead, had a very low proportion of bakers. These divergences from place to place raise some interesting problems. They may be due to a survival of household baking, or to the greater efficiency of large urban bakeries, which would decrease the proportion of bakers; they may be due to the lesser efficiency of the country and small-town producer-retailer or to a large proportion of married women at work who would tend to buy all confectionery as well as bread, which would increase the proportion of bakers. The Lancashire weaving towns had a large number of small bakeries and a high proportion of women at work; both these conditions favour a high proportion of bakers to total population. Conditions in the Lancashire spinning towns present similar features, though not to the same degree. The seaside towns have a high proportion of bakers because of their swollen summer population, for the ratio is necessarily calculated on their permanent population, which excludes the summer influx. The large cities represent the nearest approach to the average conditions in the country as a whole: they have larger bakeries than the manufacturing towns and their greater efficiency permits them to serve a large number of the total population.

But it cannot be assumed that the bakers resident in a specified

area serve only the population in that area. The example of Merseyside will make the point clear. The ratios for those administrative areas on Merseyside for which particulars are available in 1931 were as follows: Bootle 1 in 122, Waterloo with Seaforth 1 in 177, Liverpool 1 in 186, Wallasey 1 in 196, Birkenhead 1 in 236, Bebington and Bromborough 1 in 524. The Lancashire side has more bakeries than the Cheshire side, and on the Lancashire side they are congregated mostly in Bootle and North Liverpool, comparatively near to the flour-mills adjacent to the docks. Liverpool and Bootle bakeries send bread to the Cheshire side, which is therefore not self-contained in this respect. Bebington is very largely suburban and its residential growth has been quite recent: it is almost wholly dependent on bread baked outside its administrative limits. Merseyside bakeries distribute bread within a radius of 20–25 miles, which includes Southport, St. Helens, Widnes, Wigan, Warrington, and Chester; and in summer even farther afield, to include Llandudno as well. It is, of course, the motor van that has made this wide distribution possible. Bread is similarily transported considerable distances from Glasgow bakeries. It is, in fact, shipped by coaster along the west coast of Scotland as far north as Stornoway and by rail to Fort William (121 miles) and Mallaig (161 miles). The Scottish batch-loaf will keep for a week, and these more remote parts have a delivery only at weekly intervals.

The precise siting of a bakery presents some interesting problems. Merseyside may again be used as an example. The older bakeries are in the midst of a zone of working-class property lying behind the flour-mills, themselves adjacent to the docks. There is only a short haul by road from flour-mill to bakery and the millers commonly undertake the cartage. The weight of flour used in baking is substantial and a short haul is a great advantage. Baking, however, is not a weight-losing industry, for bread gains weight in manufacture, being one-third as much again as the flour and other baking materials (excluding water) put into it. The transport problem of the bakery consists only in part of the cartage of raw materials. Much more complex is the problem of the delivery of bread to the consumer. Hence the pull of the consuming district as a factor in bakery location. At the time of their establishment the older bakeries were in the midst of working-class housing, but the property has since deteriorated, and the market served by these bakeries now covers the entire built-up area and is no longer limited to their immediate environs. It is only the small producer-retailer who serves a purely local market. The older sites near the flour-mills and in the midst of old working-class property have not now all the advantages they possessed at the time when they were first built. With the outspread of population a suburban site has become equally suitable for the purposes of bread distribution and actually desirable

from the point of view of purity of product and of health of workers. The newer bakeries are, hence, in the outer districts, especially in the vicinity of the peripheral Corporation housing estates which provide part of their labour. Further migration into the outer districts is anticipated in the future.

III

MANUFACTURE OF BISCUITS AND ANIMAL FEEDING STUFFS

Bread baking is not the only industry derived from grain-milling. The manufacture of biscuits and of animal feeding stuffs are other derivatives, but it is proposed to consider them here only in a most summary fashion.

All tests of mobility, weight and cost of materials, value of product per ton, place biscuit-making along with bread baking as a relatively mobile industry. But biscuits and bread have rather different distributions over the face of the country. Biscuits will keep longer than bread; they are weight for weight more valuable than bread, and they have come to be made by large firms in large factories practising the economies of large-scale production and each having a more or less nation-wide market, except during the controls of war-time. For these reasons biscuit manufacture is much less ubiquitous than bread making, and biscuits will stand long-distance transport without materially increasing the price to the consumer. The chief biscuit factories are in Reading, Carlisle, Liverpool, Manchester, London, Edinburgh, Glasgow. Biscuit manufacture is thus an industry not only of the large firm, but also of the large town. It will be noticed, however, that the main centres cover between them each of the large sectors of the country, a circumstance used by the Ministry of Food in its war-time zoning scheme. Each biscuit factory has a large market close at hand and each is suitably placed for the supply of a large sector of Britain. It is noticeable that none of the large biscuit manufacturers are in the remote corners of the country, such as the Highlands, North-east Scotland, West Wales, or the South-west Peninsula.

Provender milling and the manufacture of animal feeding stuffs is a derivative of another kind. They work up the offals of flour-milling and of oil-seed crushing and their market is not the human but the animal population of the country. The tests of weight of materials and cost of materials as a percentage of gross output, give both provender milling and cattle and poultry food manufacture a low degree of mobility with regard to the materials they employ, lower than bread or biscuits. Their products, moreover, are relatively low in value in proportion to weight, but there is little loss of weight in the course of manufacture. Their raw materials originate in (*a*) the arable districts and (*b*) the general ports with a large import

trade; their markets are the rural stock districts and the horse (and cow) population of the towns. The provender mills are widespread. There are innumerable small mills, many of them former flour-mills (and including windmills and water-mills, as well as steam-mills) scattered throughout the country districts, arable and grass alike. There are many provender mills, often again former flour-mills, also in the towns in order to supply the urban horse population. Most of the port flour-mills have a provender mill attached to deal with the by-products of flour-milling, and some mill other grains, as well as wheat, in order to supply a greater range of animal foodstuffs. The factors *vis-à-vis* location at raw materials or at market give conflicting results and the actual distribution is such that both types of location are involved. The makers of compound feeding stuffs have a more limited distribution. Greater London and Merseyside together in the inter-war period accounted for two-thirds of the total numbers employed. This has a greater correlation with the distribution of oil-seed crushing than with the distribution of flour-milling, although it is dependent on both for its raw materials. The making of compound feeding stuffs is a comparatively new industry and was rapidly growing during the inter-war period. It is in the hands of relatively large establishments, partly because of economies of production and partly because of the considerable advisory services which the large firms can offer, but which the small firms could not afford. These advisory services have substantially stimulated the market for compound cakes. Moreover, the large firm can manufacture a wide range of cakes adapted to the nutritional requirements of different classes of animals, at different ages and under different feeding conditions. With their wheat offals, their oil-seed residues, and their ability to import whole grain from any part of the world, the ports have a much great variety of raw materials available to the cake-makers for their varied products than a cake-mill in a rural arable or stock district. A port site has not the same supreme advantages to a provender miller with a smaller range of products. The equipment he requires is not elaborate, for the whole grain is milled, and for this purpose millstones are as satisfactory as rollers; the millstones are often to hand in rural flour-mills which have lost their flour trade to the large port mills. Moreover, provender milling is frequently seasonal, as provender in rural areas is most in demand in the winter months and the provender miller can then call on rural labour employed in the fields during the summer. Indeed, much provender milling was formerly done on the farm itself. Finally, provender millers use home-grown grain rather than imported grain, for British wheat, and frequently other grains, are cheaper. Home-grown oats, moreover, have better feeding qualities than imported oats, although the imported grain, being drier, is easier to handle.[1]

[1] J. F. Lockwood, *Provender Milling* (1945); *Report on Marketing of Wheat, Barley, and Oats in England and Wales* (1928).

CHAPTER XIV

INLAND AND OCEAN TRANSPORT

THE present economy of Great Britain, both agricultural and industrial, has been built up on the basis of an elaborate and unfettered exchange of goods within the country and with other parts of the world. Means of transport are a prerequisite of specialization, whether of a farmer concentrating his attention on particular kinds of stock, but growing only a proportion of their food requirements, or of a manufacturer drawing in his raw materials from and sending out his finished commodities to the far corners of the earth. The provision of transport services are not only a prerequisite of economic specialization, but they frequently also condition the nature of that specialization in a particular case. An economic geography would not be complete without an analysis of transport. I will consider, first, means of internal transport within Great Britain and, later, shipping services between Great Britain and the rest of the world.

I

DIFFERENCES BETWEEN ROAD, RAIL AND CANAL AS WAYS OF TRANSPORT

Canal, road, and rail, differ very substantially in many respects as ways of transport, and it will be useful to consider briefly these differences at the very outset.

They differ in their physical qualities and in their relationship to land-physique and gradient. By its very nature, a canal follows the contours and surmounts gradients by means of steps, each step marked by a lock, rather than by an inclined plane. The passage of such locks involves delay and loss of water, and the tendency in British canal construction in the eighteenth and nineteenth centuries was to construct contour canals even though this involved a more circuitous route. The course taken by the Leeds and Liverpool Canal from Parbold, west of Wigan, to its terminus at Leeds Street, in the heart of Liverpool, is an example; it keeps to the 50-ft. contour in wide-sweeping curves which double its length. If the British canal system were to be constructed afresh at the present day it is probable that more direct routes with more cuttings and embankments would be adopted. The canal, therefore, keeps to low ground and penetrates upland country only by way of deep-cut valleys. Navigable rivers are even more closely confined to lowland country, their upper courses having insufficient depth of water, as well as too swift a flow, for the safe carriage of goods. A railway is also sensitive to the physique of the land, but not to the same degree. A railway engine surmounts

gradients by an inclined plane which involves very much less delay than the bodily lifting of a canal barge by the filling of a lock from a higher level. There is a limit, however, to the steepness of the gradient which a railway engine, hauling a paying load, can economically surmount. Steep gradients imply shorter trains, greater fuel consumption per unit of work performed, and frequently two engines instead of one. A railway, therefore, also keeps to the lower ground wherever possible, but, although it keeps to the valleys, it is not excluded from hilly country, and by means of a corkscrew ascent can reach high upland summits. Corkscrew ascents are proper, however, to very much more mountainous country of an alpine type than Great Britain possesses. The road is the least sensitive to the physique of the land. A motor or horse-drawn vehicle can surmount much steeper gradients than a railway train, partly because it presents a smaller unit load, but also partly because a rubber-tyred vehicle can maintain a better grip on the steeper slopes. Many of the older roads crossing upland surfaces made straight for the high land, almost ostentatiously in some cases, and avoided the valley floors, due to their softness and wetness. It not infrequently happened, too, that an upland road with its steep gradients was a more direct route than a valley road which had to wind with the valley floor. Many of these steep upland roads are in full use to-day, though their steepest stretches have been graded. For example, of the three main roads over the Pennines from the Manchester region to the wool textile districts of West Yorkshire, two follow the high passes of Blackstone Edge and Stanedge respectively and only one, which crosses and recrosses railway and canal on a narrow valley floor, follows a valley route, that of the Roch and the Calder.

The three methods of transport differ, secondly, in the speed with which vehicles pass along them. The inland waterway is the slowest, partly because water-borne traffic has always been slow and partly because of the danger to canal and river banks of the wash from a swiftly moving boat. Banks can be protected and reinforced, however, and this is a restraint on speed only in their present condition, for they could be improved. If they carried a heavier and faster traffic, the canals would need to remodel and improve their permanent way in the same way as the railways and the roads. The narrowness of canals, especially under bridges and at locks, is a further deterrent to speed, but this, although an existing characteristic, is again by no means an irremediable one. Those rivers which are navigable have not this handicap of narrowness. Nevertheless, however much traffic on inland waterways may be speeded up, it is probable that in Britain they would continue to handle the slow traffic. Traffic by road and rail moves much more quickly. The problem of wash does not arise and the wheeled vehicle is geared to swift movement. Average speed is greater by railway than by road, for traffic rather

than for mechanical reasons. A motor vehicle can travel as fast as a railway engine, but traffic on the road is not organized as traffic on the railway to permit, so long as trains run to time, a smooth and unencumbered flow. Further, road speeds are reduced by road sinuousity, though sinuousity is a characteristic of local roads (whether remodelled or not to meet the needs of long-distance traffic) and is not a characteristic of arterial roads planned like railways independently of pre-existing tracks.

There is a third difference between canal, road, and rail, in the size and carrying capacity of the transport unit. The unit on most British inland waterways is the single barge or single narrow boat with a carrying capacity of 60 and 30 tons respectively. Some navigations, however, operate larger boats, such as the flats on the Weaver, carrying up to 250 tons, or trains of boats hauled by a tug, as on the Aire and Calder, Trent and Severn. On the Aire and Calder a tug will haul up to nineteen compartment boats, representing a total cargo-carrying capacity of 660–760 tons. The train of boats is most readily operated on the river navigations and on the contour canals, both relatively free of locks, for on other canals the passage of a train of boats singly through the locks involves interminable delay. It is the small locks that are the greatest hindrance to traffic. It may be noted parenthetically that the inland waterways of Britain present a very different pattern and very different conditions from those of the Continent.[1] While the dominant element in the waterways system of Germany is the naturally navigable river, and in France the *canal latéral*, in Britain it is the canal proper, dug independently of any river course.[2] British canals, moreover, were mostly dug at a time when British life was still small-scale and relatively leisurely. They are diminutive when compared with the Manchester Ship Canal, dug during our own time. The load of road vehicles is limited even more strictly, and a limiting length of 60 feet is imposed by the Ministry of Transport on a motor vehicle with trailer. This restriction in size of motor vehicle is due partly to the restricted dimensions of the petrol-driven engine and to the sharpness of corners and curves on British roads. Although new arterial roads are planned as direct routes and eliminate right-angle bends, yet even they include sharp curves at roundabouts. In view of these conditions, and apart from any Government regulation, a train of

[1] The rivers of Britain are very much shorter in length and very much smaller in volume, they pursue independent courses to the sea and have not been integrated into a relatively few arterial rivers with extensive drainage basins as on the Continent. This is partly a result of the small size of Great Britain and partly of its sharply articulated surface, which can present nothing comparable to the North German Plain, nor even to the Paris Basin, though the London Basin is its structural counterpart.

[2] There is nothing in Britain comparable to the barges on the Rhine. A common Rhine barge has a carrying capacity of 1,350 tons and the Rhine coal traffic is worked by trains of four to five such barges drawn by a tug, giving an aggregate capacity of 5,000 to 6,000 tons.

road vehicles must necessarily be limited in number, and it consists normally of no more than two, that is, the vehicle itself plus a single trailer. From the first the railway has organized its traffic in the form of trains, many unit wagons or coaches hauled by a single locomotive steam-engine; its parent, the colliery tramway, had had similar trains of trucks. It thus provides a larger transport unit than does the road. In 1945 the average freight train load was 155 tons, which is larger than the average of river and canal barges operated singly, but lesser than the maximum load of a barge train hauled by a tug. Freight train loads in Britain, however, are comparatively low owing (*a*) to the varied topography with its innumerable changes of slope (for a freight train cannot haul more than the steepest gradient on a particular run will allow), (*b*) to the use of small-capacity wagons, and (*c*) to the characteristics of British business practice in ordering small lots at frequent intervals. American freight train loads are very much greater than the British, owing partly to the vast expanses of level country in interior North America, but owing partly also to the employment of wagons of higher capacity and to a larger average size of consignment. Freight train loads in Britain could unquestionably be increased[1]: they were, in fact, increased by over a quarter between 1938 and 1945.

Road, rail, and canal differ, fourthly, in their elasticity as ways of transport. The most elastic is the road. Railways require elaborate cuttings, embankments, and tunnels; canals require channels dug into the earth's surface, and, on occasion, aqueducts and tunnels; the road can be laid like a carpet on the existing inequalities of the land surface and, unless it be an arterial road, it may receive only a minimum of grading to soften the more abrupt gradients. Canal and rail thus require a much more extensive remodelling of the landscape. The road presents fewer engineering problems, it is easier and cheaper to construct, and it is ubiquitous, penetrating beyond the regions served by canal and rail and filling in the interstices between them. But this ubiquity of the road has a correlative disadvantage in the small size of the road vehicle, which is partly a result of the very ubiquity of the road. Light railways are as elastic as roads in that they can be constructed relatively easily and abandoned, if need be, relatively readily. But permanent railroads are expensive engineering projects and their abandonment would involve considerable loss of capital, whose only other economic use would be to serve as a track for an arterial road. A main-line railroad is not likely to be built, therefore, to meet purely temporary circumstances. The railway system of Britain tends to be a main-line system

[1] The actual carrying capacity of each vehicle and of each train unit on each of the three ways of transport is subject to change with mechanical progress in respect of vehicle and engineering progress in respect of track. There is liable to be change from time to time, therefore, in the precise balance of individual vehicle carrying capacity as between the three kinds of track, waterway, road and rail.

linking together areas of production and of consumption and communicating between town and town. Some of its branch-lines built during the railway era of the nineteenth century, when every place sought the status of a railway town, have since been abandoned or semi-abandoned with the development of motor-vehicle traffic during the present century.[1] Other feeders constructed to collieries or brickworks have been abandoned, of course, whenever the wasting assets, on which collieries and brickworks are based, ceased to be worked. In any case, a railway company finds a branch-line, unless it has a heavy goods traffic, generally uneconomical to work, and of advantage only if it acts as a feeder to main-line services. The railway is thus tending to become more and more a main-line system. The canal is the least elastic of the three. It is unadaptable to any other kind of economic use if its traffic dwindles away and it has to be abandoned, unless there be a financial return from such minor uses as the supply of water to canal-side factories or fishing or pleasure boating. Moreover, branch canals are as expensive to construct as main canals and even in the canal era, when many places sought the status of a canal town, just as later they sought the status of a railway town, the feeders to the canals were wagon tramways and roads rather than branch canals. In plan the canal is pre-eminently a main-line system dependent on traffic originating along its banks at factories or mineral workings.

There are further differences between road, rail, and canal in respect of their economic organization and of their methods of rate charging, which have effects on the nature and volume of their traffic. Something will be said of these later. Traffic, whether by rail, road, or canal, is a geographical phenomenon: it involves a material modification of the landscape, and it has results on the distribution of production and of population, results which differ according to the particular means of transport involved.

II

INLAND WATERWAYS

Fig. 81 shows the pattern of inland waterways for England and Wales. I propose, before examining the regional groups which this map displays, to discuss some general characteristics of the plan.

The first is the extreme sensitivity to the physique of the land. It is expressed in the major features of the pattern: the highlands of Wales and of the North and South Pennines are alike avoided, though canals do traverse the lower Central Pennines.[2] It is expressed also in the minor features of the pattern, for almost every inland waterway displays this sensitivity to the physique of the land in detail, and the early

[1] The form this has usually taken has been the cessation of passenger trains, but the retention of goods trains.

[2] i.e. the textile industrial districts of Lancashire and Yorkshire.

canal engineers clearly had a remarkable eye for physique. Further examples in North-west England may be found in my *Physical Survey of Merseyside.*[1] The Kennet and Avon Canal[2] makes the most direct traverse of southern England from Thames to Severn. It leads off from the Thames at Reading and passes westward along the synclinal Vale of Kennet, which penetrates into the heart of the downlands. Almost in line, though a little

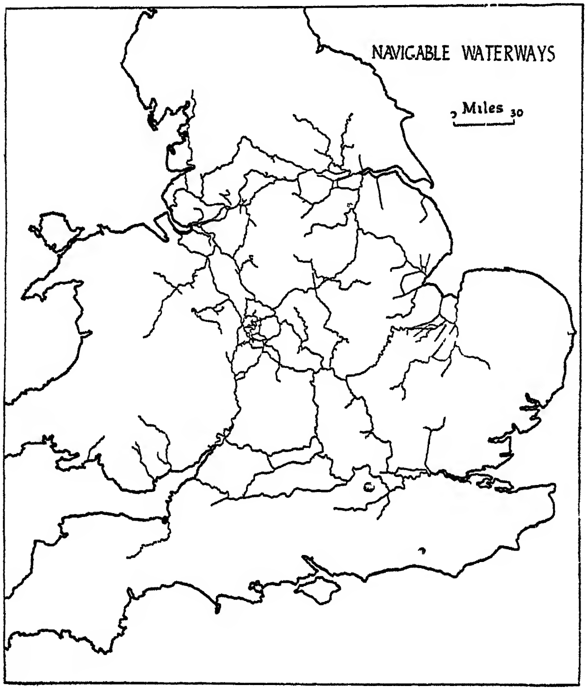

Fig. 81

NAVIGABLE WATERWAYS IN ENGLAND AND WALES

to the south, is the anticlinal Vale of Pewsey, which penetrates into the heart of the downlands from the west. The two pincer arms leave only a short stretch of summit between them, and this is pierced by the Savernake tunnel. The Kennet and Avon Canal then passes through the Vale of Pewsey, falls to the Avon plain by a flight of locks at Devizes, and thence passes via the River Avon to the Bristol Channel. The Grand Union Canal (formerly the Grand Junction), to give another example, traverses the Northamptonshire Uplands by the Daventry gap and the Chilterns

[1] W. Smith, *Physical Survey of Merseyside* (1946), pp. 52–5.
[2] The names of the canals are those employed prior to nationalization.

by the Tring gap, the very same routes as Watling Street had taken long before the canal era, and as the London and North Western Railway (later the London Midland and Scottish Railway) followed after the canal era. At Watford, instead of traversing the West London plateau to the heart of London (the route taken by the railway), the canal swings around the edge of the plateau to Brentford, where it debouches on to the Thames.

The second point to note in the inland waterways pattern of Britain is its relation to the industrial areas, particularly to those industrial areas existing at the time of the canal era, approximately 1750–1830. The canal system of Britain was constructed during a specific and limited historical period to meet precisely the conditions of the period.[1] However topographically easy the route, a waterway is of little value for transport unless traffic originates along its banks. The canal network is closest on and around the *inland* coalfields and on the routes linking these inland coalfields with the sea. The inland coalfields had become, or were in process of becoming, centres of the new steam industrialism at the time of the canal era. The coastal coalfields of South Wales and of the North-east Coast had inland waterways to a very much less extent because of their coastal position and because of the existence of the wagon tramway, which, with trucks moving by a down gradient to the coast without the complications resultant upon locks, was perhaps better adapted than the canal to the primarily one-way traffic of these districts. The Fenlands and East Anglia, whose topography would seem to be marked out by nature for water-borne traffic, have had very little actual traffic owing to the agricultural and non-industrial character of the region. There is some traffic to-day to the sugar-beet factories, but this has been a development entirely of the inter-war period. Suitability of land-physique is clearly not enough. Canals are not confined, however, to the inland coalfields and to the routes linking them with the sea. There are canals across southern England from Thames to Severn, but they are now virtually derelict owing to lack of originating traffic along their route. Even at the time of construction during the Revolutionary and Napoleonic Wars, they were the result of traffic imitation rather than of traffic need and the result of the strategic design of an inland waterway to avoid the risks of the English Channel made unsafe by the activities of French privateers.

The third point is that the inland waterways system comprises three or four different kinds of members—the estuarine waterways and canals suitable for ocean-going traffic, the naturally navigable

[1] This is displayed in the very place-names mentioned in the Canal Acts. In 1783 an Act permitted the construction of a canal from Rider's Green to Broadwater Fire Engine, and of several collateral cuts, among which were those from Butcher's Forge Pool to Brooke's Meadow, from Butcher's Forge Pool to Wood's Engine Forge (J. Priestley, *Historical Account of the Navigable Rivers, Canals, and Railways of Great Britain* (1831), pp. 64–5).

rivers, the barge canals broad enough to take barges and the narrow canals too narrow to take barges. The first member is not properly a part of the inland waterways system at all, for it represents a penetration inland of the sea. Thus the Manchester Ship Canal, apart from the Eastham Locks at its seaward end which insulate it from tidal rise and fall, burrows inland and has its first locks at Irlam, some 30 miles from its seaward end: while the Bridgewater Canal, parallel to it, but a member of the inland system, is a contour canal from its inland terminus at Manchester to Runcorn; where it descends to the Mersey by a great flight of locks, apart from which it would remain suspended above sea-level. The Manchester Ship Canal penetrates inland from the sea, the Bridgewater Canal reaches out seaward from the land. The naturally navigable rivers, of course, are the product of nature and have not required large capital expenditure to create navigability. It is true that there is expenditure on the grading and the maintenance of the navigability of the river channel, but there is no expenditure necessary to obtain water supplies to maintain the waterway. The naturally navigable waterways, therefore, should provide a cheaper route than the artificially constructed canal, with the burden of capital expenditure which that entails. Moreover, the greater width of the navigable river, as compared with the canal, permits larger barges and the train of barges or of compartment boats, which also reduces cost of transport. The navigable rivers thus offer advantageous routes or tracks, but not all navigable rivers have a traffic appropriate to the track which they possess. Some navigable rivers are open and unencumbered by locks, others are locked and are strictly navigations. Where they have a large general port, their estuarine stretches are busy with the distributive trade of that port; the Thames, Mersey, Humber, Clyde, and Bristol Channel, are examples. But navigable rivers without such a port carry a heavy traffic only where they pass through those industrial and agricultural areas which provide the kind of traffic in which British inland waterways have specialized. Examples of such areas are the northern fringe of the West Yorkshire coalfield traversed by the Aire and Calder Navigation and those Fenland fields growing sugar beet with direct access by water to a sugar-beet factory. There are many navigable rivers, however, with very little traffic because they are badly placed relative to areas where traffic originates. Within the artificially constructed canals there are important distinctions in minimum width of channel and in dimensions of locks. The minimum widths are encountered not in the main channel, but under bridges and in locks, which were frequently made as narrow as possible in order to economize in the expense of building bridges over the canal and in the expense of supplying water to locks. The critical width is 14 feet, for, if the canal is wider than this at its narrowest point, it can take 60-ton barges, but, if narrower, it can

take only the 30-ton narrow boats. The barge and the narrow canals are distributed unequally over the face of the country. The narrow canals are most numerous in the Midlands, the barge canals in the North of England. It may not be altogether fanciful to suppose that the canals of the North of England, with its substantial rainfall and its many sites for impounding reservoirs, were not faced with the need for water economy, while the Midland canals, in an area of lesser rainfall, of porous rocks, and of few sites for impounding reservoirs, were compelled to use water sparingly. The Birmingham canals depend for their water on the expensive method of pumping from disused coal-mines. This is a summary only of the relative regional frequency of barge and narrow canals. The difference between them has results on the volume of their traffic. The *Final Report* of the Royal Commission on Canals and Waterways declared, 'It is important to observe that while the mileage of English narrow canals is approximately the same as that of the barge canals and navigations, upon the latter is carried by far the larger proportion of the total inland water traffic of the country . . . they carry, approximately, twice as much tonnage per mile as do the narrow canals.'[1] The mileage of these several kinds of inland waterways, as given in the *Final Report* of the Royal Commission in 1909, is set out in Table XCIV.

TABLE XCIV

Mileage of Varieties of Canals and Inland Waterways

	Over 14 ft. wide	Under 14 ft. wide	Total
Open rivers	813	—	813
Navigations	834	479	1,313
Canals	762	1,165	1,927
	2,409	1,644	4,053

From *Final Report*, Royal Commission on Canals and Waterways (1909).

It will be noticed that nearly two-thirds of the mileage of the navigations are of barge width, but that only two-fifths of the canals have these dimensions. The British waterways system consists to a very much less extent than continental waterways of open rivers and navigations and to a very much larger extent of artificially constructed canals.

The main groupings of the system are the following:

[1] *Final Report*, Cd. 4979 (1909), p. 45. The statistics to the nearest 100 tons are 7,500 tons per mile on the narrow canals and 14,200 tons per mile on the barge canals. These exclude the Birmingham Canals (narrow) and the Sheffield and South Yorkshire Navigation (wide), and they refer to a sample of just over half of the total mileage for three sample years combined (1888, 1898, and 1905).

(*a*) the Scottish group;
(*b*) the Lancashire and Yorkshire group;
(*c*) the Midlands group, with four arms leading to the estuaries of Mersey, Humber, Severn, and Thames;
(*d*) the Thames–Severn group.

In addition, there are the canals of the South Wales coalfield and the rivers of the Fenland. Most of these waterways are physically inter-connected, excepting only the Scottish and South Wales systems. In his *Progress of the Nation*, Porter declared that in England 'there is not any spot south of the county of Durham at a greater distance than fifteen miles from water conveyance'.[1] Fifteen miles is precisely the same distance that Dr. Willan chose for his map of the seventeenth century to indicate those areas within reasonable reach of water communication. There is not space to describe each of these groups, and attention will be confined to the second and third groups, the most important of all.

The Lancashire and Yorkshire group lies in the Lancashire–Cheshire Plain, in the Vales of York and Trent, and, as trans-Pennine routes, in the Central Pennines. In the Lancashire–Cheshire Plain the main axial line is formed by the triple route of the Mersey and Irwell Navigation, the Bridgewater Canal, and the Manchester Ship Canal. The permanent importance of this route, at the present day, as well as in the canal era and even before the canal era altogether, is clear enough. The Manchester Ship Canal takes the ocean-going vessels and the Bridgewater Canal the barge traffic. Converging on this axial line are two centripetal systems of canals, one having Manchester and the other the Mersey estuary as its objective. The centrality of Manchester within South-east Lancashire is as marked in respect of the canal as of the road and rail patterns: canals converge on it from Leigh and Wigan, from Bolton and Bury, from Rochdale and the Yorkshire Calder Valley, from Ashton-under-Lyne and Huddersfield, from North-west Derbyshire and the Potteries. The Mersey estuary is equally a focus of canal routes converging from St. Helens, Manchester, the Potteries, the West Midlands, Chester, the salt towns of mid-Cheshire, and, by the Leeds and Liverpool Canal, from North Lancashire, East Lancashire, and the West Riding. This canal net involves the entire immediate hinterland of the Port of Liverpool. Road and rail with the same objectives, that is, Manchester and the Mersey estuary, now duplicate (or triplicate) the canal pattern and the volume of canal traffic has greatly declined, except along the sea-way of the Manchester Ship Canal, which is not properly an inland waterway at all. On the eastern side of the Pennines, in the Vales of York and Trent, the waterways system consists of a series of what are basically river routes (as distinct from

[1] Ed. of 1847, p. 289.

the canal routes of the Lancashire–Cheshire Plain) converging on the head of the Humber estuary.[1] The waterways systems to the east and west of the Pennines are inter-connected by trans-Pennine canals, but these are limited to the Central Pennines, being absent north of the Aire gap and to the south of the Calder basin. This limitation of trans-Pennine routes is very significant in relation to both physical and industrial conditions. To north and south physique of the land is too difficult for canal construction between east and west: high sharp edges of gritstone running in north–south directions bar the way. In the Central Pennines the gritstone moors are more rounded and are broken by east–west river valleys which have cut back towards each other from either flank to create relatively easy summit passes between them. The Central Pennines thus provide easier passages for trans-Pennine routes, but even they present sufficient physical obstacles to serve as a deterrent to canal construction had there not been a strong economic urge for inter-communication at a time when the canal offered the most advanced means to this end. The summit or watershed stretches of these trans-Pennine canals were constructed much later than the lowland stretches on either side.[2] The economic urge to construction was partly the close relationships which have long existed between the two textile districts, formerly working in the same material and still exhibiting considerable inter-digitation even to-day, the western valleys of West Yorkshire working in cotton and the Pennine flanks of Lancashire in places working in wool. There was a further economic urge in the desire of Lancashire merchants to gain access to the port of Hull and of West Yorkshire manufacturers and merchants to gain access to the port of Liverpool.[3] The easiest route, that of the Leeds and Liverpool Canal, has 104 locks between the Mersey and the Humber, but it is the most circuitous with a mileage of 161; the most difficult route with a summit tunnel, that of the Huddersfield Canal, has 147 locks and a mileage of 120. Most of these Lancashire and Yorkshire canals and navigations are of barge

[1] The pattern of these waterways on the eastern side of the Pennines, converging on the Humber estuary, has its analogue in the Lancashire–Cheshire Plain in the system converging on the Mersey estuary rather than in that converging on Manchester. The centrality of Manchester as an inland centre has no counterpart of the eastern side of the Pennines. Leeds and Sheffield are quite independent centres, and even within West Yorkshire many of the functions which Manchester fulfils for the whole of the cotton industry are for the wool textile trades shared between Leeds and Bradford. The fundamental reason for this difference is physical, the Rossendale anticline on the western side having created the Manchester basin, the cause of Manchester's centrality.

[2] The summit stretch of the Leeds and Liverpool Canal through Skipton was not opened until 1816, although there was traffic on the canal in lowland Lancashire in 1774 and in lowland Yorkshire in 1773. The Rochdale Canal across the watershed was similarly later than the Aire and Calder and Calder and Hebble Navigations.

[3] A. Redford, *Manchester Merchants and Foreign Trade, 1794–1858* (1934), Chapter XIII.

width, the main exceptions being the Huddersfield, Ashton, Peak-Forest, Macclesfield, and Chesterfield Canals.

The hub of the Midlands system lies in Birmingham and the Black Country. The Birmingham Canals coil through this highly industrialized district at three contour levels—at 408, 453, and 473 feet. Within each contour level there is complete freedom from locks, a circumstance which has greatly encouraged traffic within each level between canal-side collieries and factories. The canal is well served, too, with basins adjoining railway goods yards for transhipment to another mode of transport.[1] The Birmingham Canal, however, is narrow throughout in the sense that only narrow boats can pass through locks, and, although this may not have acted as a deterrent to local traffic within a single level, it has acted as a deterrent to long-distance transport to and from the large coastal ports whose distributive trade by water is handled by barges and lighters too broad to enter the Birmingham system. Nevertheless, this hub of the Midlands network is linked to all four estuaries of Mersey, Humber, Thames, and Bristol Channel; in each case by duplicate routes. Most of the members of this Midlands system are narrow canals incapable of taking boats of barge width. It is only towards the estuaries that the canals become wider. Thus the Severn, the Trent, and the Thames, take barges, the Shropshire Union becomes a barge canal beyond Nantwich, the Grand Union beyond Braunston, the Grand Trunk beyond Middlewich. These conditions of width are of great importance in the understanding of the distribution and character of canal traffic.

The recorded traffic on British canals and waterways, excluding the open rivers and estuaries whose traffic is unrecorded, is set out in Table XCV for four separate years, and, in order to facilitate the recognition of change, the traffic of 1938 is calculated as a percentage of that of 1888, fifty years previous. Traffic statistics in the form of total tonnage are not as informative as might at first sight appear, for they give no indication of the distances over which this tonnage moves. It will be seen later that the average distances travelled per ton are very much greater on the railway than on the canal. The ton-mileage returns which take into account mileage as well as tonnage are a very much more accurate index of traffic density than tonnage alone. Unfortunately, the only canal ton-mileage returns for separate waterways refer to a few samples specially collected for the Royal Commission on Canals and Waterways some forty years ago. In order to compare one canal with another it is necessary to eliminate the variable of length, and the last column in Table XCV gives the density of traffic in thousand tons per mile. This table permits a number of very interesting conclusions.

[1] In 1905 there were 550 private basins and branches, many of them belonging to the railway companies.

TABLE XCV

Traffic on Selected British Canals and Navigations, 1888–1938

	In thousand tons 1888	1905	1925	1938	1938 as per-cent of 1888	Mile-age in 1927	Tons per mile in 1938 in thous.
Forth and Clyde and Monkland Canals	1,257	932	170	110	9	48	2
Aire and Calder Navigation	2,211	2,811	2,466	2,400	109	71	34
Sheffield and South Yorkshire Navigation	927	836	449	738	80	59¾	12
Trent Navigation	200	350	413	589	295	99½	6
Fossdyke Canal	26	76	66	65	250	11¼	6
Nottingham Canal	109	123	101	*	—	15	—
Erewash Canal	111	80	22	—	—	11¾	—
Leeds and Liverpool Canal	2,017	2,468	1,738	1,459	72	142½	10
Calder and Hebble Navigation	580	463	312	268	46	23¼	12
Rochdale Canal	686	555	146	19	3	35	1
Huddersfield Canal	180	98	42	17	9	23¼	1
Bridgewater Canal	2,770‖	2,170‖	1,283	1,045	36	37	28
Manchester, Bolton, and Bury Canal	620	654	220	87	14	12½	7
St. Helens Canal	504	293	119	94	19	15¾	6
Weaver Navigation	1,498	1,077	700	567	38	22½	25
Shropshire Union Canal	1,125	605	427	215	19	197	1
Trent and Mersey Canal	1,139	1,138	517	286	25	118	2
Birmingham Canal	7,713	7,546	4,363	2,034	26	159	13
Staffordshire and Worcestershire Canal	646	723	473	398	61	51	8
Stourbridge Canal	121	335	166	59	49	7¼	8
Worcester and Birmingham Canal	393†	392†	209	124	32	30	4
Severn Navigation	323	288	140	342	106	52	7
Coventry Canal	452	426	460	386	85	32½	12
Loughborough Navigation	80	61	29			9¼	
Leicester Navigation	96	83	60			15¾	
Birmingham and Warwick Junction Canal	195	289	376			2¼	
Warwick and Birmingham Canal	353	326	241	1,811	48	23	6
Warwick and Napton Canal	236	180	127			14¼	
Grand Junction Canal	1,172	1,794	1,485			188½	
Regent's Canal	1,673	1,045	670			—	
Oxford Canal	450	379	357	383	85	81¾	5
Thames	729	1,396	361	274	38	125½	2
Thames and Severn Canal	35	17	—	—	—	30‡	—
Stroudwater Canal	68	43	16	1	1	8	—
Kennet and Avon Navigation	136	64	29	13	10	86½	—
Swansea Canal	386	123	30	—	—	16½	—

* With Trent Navigation. † Including Droitwich Canal.
‡ Mileage in 1905. ‖ Including Mersey and Irwell Navigation.

From *Final Report*, Royal Commission on Canals and Waterways and from *Railway Returns for 1938*.

The first point is the varying density of traffic between one waterway and another. Some had a traffic which was virtually negligible, others a density up to 34,000 tons per mile. Those with the lowest densities comprise the waterways of East Anglia and the Fenland, the Thames and canals across southern England, the Scottish and the South Wales canals. These traverse regions, such as the Fenlands or southern England, with little originating traffic of the kind which travels by water, and they traverse regions, such as central Scotland, which were never deeply involved in canal traffic even in the canal era. To this group may be added the summit stretches of the trans-Pennine canals (Rochdale, Huddersfield, Trent and Mersey), which have fallen into decay because they are choked with locks. Low density of traffic may thus be caused by either economic or physical causes. Those waterways with the highest density of traffic, in order, were the Aire and Calder Navigation, the Bridgewater Canal, and the Weaver Navigation. These are all relatively broad waterways which can take boats of over 60-ton capacity—Mersey flats of 80 tons on the Bridgewater, Weaver flats of 250 tons (and small coasters of 500 tons) on the Weaver, the train of compartment boats with an aggregate capacity of 660–760 tons on the Aire and Calder. They have few locks and they each traverse territory where there is an abundance of originating traffic. They thus clearly possess both physical and economic advantages. They were the waterways commended by the Port Facilities Committee of the Chamber of Shipping of the United Kingdom as 'of great value as an adjunct to shipping facilities'.[1] If it be possible to classify traffic densities in regional terms, it would be along these lines. Class A, with the highest densities, contains only broad waterways having access to estuarine waters in the lower ground of the industrial districts of Lancashire–Cheshire and Yorkshire. Class B comprises other canals and waterways within these same districts, together with canals in the heart of the inland Midland coalfields. Class C consists primarily of Midland canals along the routes linking the heart of the Midland system with the estuaries of the Mersey, Humber, Severn, and Thames. Class D includes several waterways in the same regional areas as Class C, but Class E, having the lowest densities of all, consists of canals and waterways on the outermost periphery of the entire British canal system—Scotland, South Wales, southern England (south of the Thames), East Anglia, and the Fenland.

The decline in density as the waterway route passes from lowland to highland is clearly displayed in several examples, and would be more generally evident if traffics for separate sections of large and composite groups were available. The 34,000 tons per mile on the Aire and Calder Navigation diminished to 12,000 on the Calder and

[1] *Second Report* (1929), p. 26.

Hebble Navigation and to 10,000 on the Leeds and Liverpool Canal, which lead upstream from either arm of the Aire and Calder Navigation, and these in turn diminished to under 1,000 tons per mile on the Rochdale and Huddersfield Canals, which continue the Calder and Hebble route across the Pennine watershed.

The second point of interest in Table XCV is the trend of traffic within the fifty-year period. Some waterways had lost all or virtually all their traffic, others had increased their traffic as compared with 1888. Taking all waterways for which traffic is recorded at both extremities, in 1938 as well as in 1888, there was a marked decline from 34 million tons in 1888 to 11 in 1938, and, if all waterways were to be included, the decline would prove to have been greater still. The total waterways traffic of Great Britain in 1938 was less than a third of what it had been fifty years earlier. From an examination of the order of individual canals and waterways in respect of density of traffic and in respect of the trend of their traffic, it is clear that the conditions favouring density of traffic and the retention of that density are:

(*a*) a broad highway permitting large barges and having the minimum of encumbrances to navigation in the form of locks;[1]

(*b*) bulk commodity traffic originating along its banks, either at scattered points as from collieries or from a single point as an importing port, and loaded direct into barges without transhipment;

(*c*) a destination along the waterway itself for such bulk traffic originating along its banks;

(*d*) a management which encourages the maximum use of the waterway.

The Aire and Calder Navigation, which had the greatest density of traffic of all in 1938, fulfils each of these conditions in a marked degree; some, such as the Birmingham and Leeds and Liverpool Canals, satisfy some of these conditions, but not all; still others, such as the Wiltshire and Berkshire Canal, satisfy none of these conditions and have negligible traffic. The Aire and Calder Navigation is a broad waterway; it receives coal from collieries on or near its banks;

[1] This had come to be a much more significant factor in 1938 than it had been fifty years previous. In 1938 the density of traffic per mile to the nearest 100 tons was 4,300 for narrow canals, 9,700 for wide canals, and 10,250 for wide navigations. In 1888 the densities had been 13,850, 18,200, and 10,400 tons respectively. These densities are only approximate and the comparison must not be pushed too far, but the differences between the three groups are so acute that they cannot be wholly false. The Birmingham Canals have been included with the narrow canals: if they were excluded, the contrast between narrow and wide in the density of traffic would be still more pronounced. The navigations have maintained their densities, the wide canals have had their densities halved, the narrow canals have had their densities reduced to less than a third. The factor of width of waterway, scarcely a handicap at all in 1888, had become progressively more significant with time.

it discharges this coal for coastwise or foreign shipment at Goole; it has a management which is eager to provide facilities. But the density even on this waterway is a mere fraction of the density on the German waterways, which had a density for the *whole* system in 1936 of no less than 3,389,000 tons per mile of route, a reflection not only of much more favourable physical conditions, but also of direct state planning.

The canal traffic returns made annually to the Ministry of Transport permit a commodity analysis of waterways traffic. These are set out for 1938 in Table XCVI. For the whole set of inland waterways coal was responsible for nearly half of the total traffic and the rest consisted primarily of other bulky cargoes—building materials, industrial raw materials, foodstuffs, liquids in bulk, timber, manures. Industrial products, defined as such, contributed less than 10 per cent of the total. It is, however, by no means easy to define the precise proportion which the products of industry contribute, for some of the foodstuffs, for example, are manufactured products, such as flour. The transport of bulky commodities is thus the economic function of the canal. Such commodities are obtained in bulk from mine or factory or ocean-going vessel, and they are unloaded in bulk into factory or warehouse or ocean-going vessel. Commodities which do not offer these conditions of bulk handling, either by reason of the nature of the commodities themselves or of the conditions under which they originate, are carried by canal to only a limited extent.

The precise commodities carried by any particular canal vary widely. There is wide variation in respect of every commodity group. Coal presents the nearest approach to uniformity, but the contribution of coal to total traffic varied in 1938 between nil and 93 per cent. Coal constitutes a canal cargo, not only when it originates from collieries, but also when it is distributed to canal-side factories, gas-works, power-stations, and even to wharves serving retail coal distributors. As a percentage of total traffic, coal is most important on those canals which traverse a coalfield, but it is important also on the Oxford, Grand Union, and Thames, which distribute coal for household or industrial consumption from the Midland fields and from the coastwise traffic having its terminus in the Port of London. There are, however, coalfield canals, such as the St. Helens Canal, with little or no coal traffic. It can only be concluded that canals passing through a coalfield do not acquire a coal traffic automatically without seeking it. Very few waterways have a substantial traffic in what are classified as industrial products, and these are frequently of a highly specialized type. They bulk largest, both actually and relatively, on the Weaver Navigation, where they are processed salt and alkalis being transported from the mid-Cheshire salt-field to chemical works at the head of the Mersey estuary. The other waterways with a substantial traffic in industrial products are the St.

TABLE XCVI

Commodities Carried on Selected British Canals and Navigations, 1938

	In thousand tons						
	Coal and coke	Building materials	Raw materials	Industrial products	Foodstuffs	Bulk liquids	Total
Forth and Clyde and Monkland	9	14	7	1	—	31	110
Aire and Calder Navigation	1,704	56	174	94	129	218	2,400
Sheffield and South Yorkshire Navigation	486	21	93	1	75	53	738
Trent	11	216	25	27	125	154	589
Fossdyke Canal	—	7	4	—	45	1	65
Leeds and Liverpool Canal	1,002	33	44	31	298	4	1,459
Calder and Hebble Navigation	192	15	14	2	38	5	268
Rochdale Canal	12	—	2	1	—	—	19
Huddersfield Canal	4	7	1	1	3	—	17
Bridgewater Canal	508	4	159	104	211	36	1,045
Manchester, Bolton, and Bury Canal	81	—	5	—	—	—	87
St. Helens Canal	—	—	—	22	72	—	94
Weaver Navigation	—	6	60	461	1	34	567
Shropshire Union	16	34	17	27	58	58	215
Trent and Mersey Canal	45	6	112	54	20	41	286
Birmingham Canal	1,205	40	203	145	78	211	2,034
Staffordshire and Worcestershire Canal	171	9	35	45	61	59	398
Stourbridge Canal	8	29	15	7	—	—	59
Worcester and Birmingham Canal	32	1	3	6	62	6	124
Severn Navigation	1	1	8	3	77	243	342
Coventry Canal	308	45	6	8	2	—	386
Grand Union Canal	575	390	61	146	148	105	1,811
Oxford Canal	231	30	42	14	37	4	383
Thames	149	11	5	—	26	4	274
Kennet and Avon Navigation	1	—	—	1	8	2	13
	6,158	1,068	871	1,139	1,340	1,329	12,952

From *Railway Returns for 1938.*

In the total, traffic which travels on more than one waterway is reckoned only once; the aggregate total of individual waterways thus exceeds the total as given above.

Helens, Bridgewater, Aire and Calder, and Trent, which serve industrial Lancashire and West Yorkshire respectively, together with a group of West Midland canals, notably the Birmingham and the Trent and Mersey. It is precisely the same canals which have a traffic in industrial raw materials. The traffic in foodstuffs is mainly in two commodities—grain and sugar beet. Canal grain traffic is largely, if not entirely, the distributive trade of the large importing

ports, shipped from overseas tramps into canal barges and thence to canal-side flour-mills. The Leeds and Liverpool, Aire and Calder, Trent, Bridgewater, and Grand Union all lead inland from the large grain importing ports of Liverpool, Hull, and London. Sugar-beet traffic is limited to the rivers of the Wash, the Trent, and the Ouse, on which the beets are transported from farm to factory. On the St. Helens Canal the traffic in foodstuffs is of raw sugar transported in bulk from the port of Liverpool to a sugar refinery on the canal banks. The traffic in bulk liquids, largely refined petroleum, is as much a distributive trade from large importing ports as grain. The Aire and Calder, the Trent, the Severn, the Grand Union, together with the Birmingham Canal, handle the greater part of this traffic. It is clear that the particular commodities handled are determined, to pick out the largest general factors, by the presence or absence of a coalfield and of the import trade of a large general port.

Inland waterways traffic in Britain thus consists primarily of bulk commodities, relatively low in value in proportion to their bulk, a condition which is true of most of the industrial products equally with the raw materials, the coal and the foodstuffs. Sample inquiries of mileages were made by the Royal Commission on Canals and Inland Waterways, the sample given in its *Final Report* covering 31 per cent of the total traffic in 1905. The average mileage per ton of this sample was 17·5, but there was some variation from canal to canal, the longest canals having higher average mileages than the shorter. The mileage returns are now, since nationalization, available for the canal system as a whole and for each of the divisions, though not for individual waterways. In 1949, average mileage per ton was 16·9 for all commodities, coal being 14·7, these being of the same order of magnitude as in 1905. The longest distances travelled were in the North-Eastern Division which includes Yorkshire and some Midland counties. These are low figures and very much below the average mileage on the railway for comparable classes of commodities.[1] This short-distance character of British waterways traffic is the more striking in comparison with the much longer distance traffic of similarly bulky commodities on continental waterways.[2] In attempting to understand British traffic we have thus to consider not only a condition, that of bulky traffic, proper to all inland waterways, but also a further condition, that of short-distance, peculiar to Britain.

The short-distance traffic peculiar to Britain is due to the peculiar characteristics of British inland waterways. Britain has a large mileage of canals as compared with river navigations and, within the canals, a large proportion of narrow as compared with barge canals. As compared with the large arterial waterways of the North German Plain, the British canals are of almost toy-like dimensions. These

[1] Average length of haul on the railway was 74 miles in 1950.
[2] In Germany in 1936 the average distance travelled was approximately 140 miles.

conditions are unsuitable for long-distance traffic. Moreover, the lay-out of the British economic geography in relation to waterway routes is such that only relatively short distances are involved. Industrial districts and large centres of population are in close proximity to coalfields and the distances from ports to inland centres are considerable only in respect of the Midlands. There is a huge traffic along the Rhine upstream and downstream from the Ruhr, along the routes converging on Berlin, and also on the Oise and Lower Seine to Paris, but there is no such traffic by water converging on London, which, as a consuming centre removed from a coalfield, offers the nearest British analogy to Berlin or Paris. While Berlin and Paris receive coal by inland waterway, London receives coal coastwise and by rail. In the canal era there had been more long-distance traffic than in 1905, but it was then not of coal but of relatively high-grade commodities which were early lost to the railway. It may be argued, as shipping interests frequently do, that the real British equivalent of the inland waterways of Germany and of the United States is not the canal but the coasting trade.

Such limitation of inland water traffic to bulky commodities is common to most countries in the railway age and must be inherent in the conditions of inland water transport *vis-à-vis* rail and road transport. Water transport is usually slower than by road or rail, and is not adapted, therefore, to the more valuable commodities, which under present business practice are usually dispatched in small lots. The delay and greater uncertainty of date of delivery by water is of less importance with bulky low-grade commodities, of which greater stocks are kept: the lower freight charges on some, though not all, water-borne commodities is sufficient to compensate for these disadvantages. If rail charges on bulky commodities were increased, much more bulky traffic would be driven to the waterways. Methods of railway rate charging whereby low-grade commodities pay less per ton-mile than high-grade commodities will be discussed later, but it is not without significance in reducing even the bulky traffic on the canals. Waterways suffer also in being primarily main-line routes in direct physical contact with only narrow linear zones of country, in contrast to the ubiquity of railways and especially of roads. Even this factor acts unequally on different kinds of commodities. A coal-mine can, if on a waterway, send out by water that part of its coal destined to bank-side factories or to a coastal port, but a factory drawing in materials from a wide variety of places and distributing its output to a great number of traders seeks the ubiquity of rail or road and shuns the spatial limitations of the waterway, even if the factory happens to have a canal-side site. The canals and navigations of Britain thus play a very specialized role in the present-day transport system.

Nevertheless, the canal has been of immense importance as a factor in the detailed siting of industry. Where canals pass through an industrial district they have attracted to them a whole congerie of factories and mills. The very existence of a waterway has sometimes itself created industry in an otherwise non-industrial district, but more usually it has acted as a magnet to locate industry on particular sites within an existing industrial region created by other causes. Canals threading through Birmingham and the Black Country, through the industrial towns of Lancashire and the West Riding, through the large ports of London and Liverpool, have innumerable factory premises alongside. This is especially pronounced with premises built prior to the motor age, for motor transport has made industry more independent than previously of canal and rail. But, even during the motor age, factories have been built along the larger waterways of the dimensions, or approaching the dimensions, of ship canals; it is along these arms of the sea, rather than along inland waterways proper, that such new factories have been built during the motor age. Examples are the paper-mill and flour-mills at Ellesmere Port on the Manchester Ship Canal. The attraction of the canal to industrial premises is due, first, to the function of the canal as a means of transport for industrial raw materials, for coal for power production, and for the finished products of the factory. Before the railway age, the canal was an important route of transport for a great variety of industrial raw materials and finished industrial products, but the railway eroded much of this general traffic and left to the canals only the bulky products. The canal, however, continued to be an important avenue for the transport of coal, which all factories required for the production of their motive power before the generation and transmission of electricity in bulk. The industrial value of the canal, however, is not limited to its transport function. Not infrequently canal-side factories are entirely devoid of wharfage. Many factories draw water from the canal for steam-raising, and this is the sole use made of the canal to-day by many industrial premises. A river, though not usually one carrying traffic, may be used by a factory for the disposal of effluent. Moreover, a canal is sometimes employed as a route for the transmission lines of the electric grid, as the Leeds and Liverpool Canal within the built-up area of Liverpool: it presents an open linear space and it links many bulk consumers of electricity in the form of canal-side factories.

III

RAILWAYS

The British railways network is much closer than the British canal network. While the canal mileage was in 1905 some 4,053, railway

route mileage was in 1949, 19,573.[1] This greater ubiquity of the railway is partly due to its lesser sensitivity to changes in physical gradient. The minutely articulated landscape of Britain, with its frequent alternation of hill and vale, limits the canal to a very much greater extent than it does the railway. The greater ubiquity of the railway is also partly due to the more general traffic handled, comprising passengers as well as goods and comprising the more valuable as well as the less valuable commodities, thus justifying its more general penetration into all parts of the country. The railway, moreover, is a more general means of transport in respect of distances as well as of commodities. Other means of transport perform more specialized functions.

Although more nearly ubiquitous, the railway pattern varies regionally in density. The denser the regional population and the smoother the landscape, the closer is the railway net; the sparser the regional population and the more mountainous the country, the more open is the railway net. In densely peopled industrial districts in lowland country, such as South Lancashire, no point may be more than 2 miles from a railway and the railway net forms a continuous pattern with no loose ends in the form of short lines terminating at a rail-head. In upland industrial districts, such as Rossendale, the interstices between the railways usually contain areas more than 2, but rarely areas more than 5, miles from a railway, but in this kind of country the population may be concentrated on the valley floors and adjacent to the railway, while the interstices may be moorland empty of population. Purely rural agricultural districts in smooth country, such as East Anglia, have usually a more open net whose interstices have points over 5 miles, though less than 10 miles, from a railway line. Such a railway net may have some loose ends and rail-head termini on branch lines, but the smoothness of the country facilitates the inter-connexion even of branch lines. In rough mountain country with a sparse population the rail net is much more open and the interstices include large tracts over 5 miles distant from a railway, and in some parts extensive tracts over 10, and even over 20 miles from a railway line. There are few points and no areas of substantial dimensions in the uplands of England and Wales more than 10 miles from a railway, but in Scotland, even in the Southern Uplands, but still more in the Highlands, there are extensive tracts. Each of the mountain districts of Britain has loose ends in its rail net, where branch lines penetrate into a mountain valley and stop short at a rail-head, a small market town, or a mining or quarrying centre. The southern flanks of the Lake District, with its rail-heads at Coniston and Boot, provide an example. Wherever such lines

[1] The canal mileage is that as given by the 1905 Commission, but many routes have been abandoned since that time. The railway mileage is that given in the *Report and Accounts for 1949* of the British Transport Commission. The mileage of canals is stated in that Report as 1,765, but this will be exclusive of the open rivers.

penetrate through the heart of the mountain mass to form part of a continuous rail net, they are usually the result not of the locally originating traffic, but of the space-relations demanding a through route despite the difficulty of the terrain. The former Midland line along Upper Ribblesdale is an example.

This liability of each type of terrain and of each type of economic region to have its own variety of railway pattern can be developed further. A manufacturing region densely packed with people, such as South Lancashire, has an intricate rail net with a cellular form permitting inter-communication between a great variety of points. A mining region exporting its output has a very different railway pattern. It is less closely packed with people, and the rail net, apart from mineral lines, is more open. The rail net, moreover, is different in form. It is less cellular and arranged more in the form of parallel or converging strands, according to the physical pattern, linking directly mines or quarries with exporting points. Such exporting points may be ports or railway junctions communicating with main railway lines. There is little need for inter-communication between any two producing points, each producing precisely the same commodity, and the cellular form is unnecessary and would, in fact, be redundant. The South Wales coalfield has these characteristics. The North-east Coast has a less extreme form of the same pattern owing to the less accentuated and less deeply dissected physique of the land and owing to the circumstance that the east coast route to Scotland runs across the parallel strands and binds them together. Coastal regions strung with holiday resorts, to give another example, have a different pattern from coastal regions without them: the former have coastal railways parallel to the shore linking each holiday centre with others of its kind, but the latter are entered by railway lines penetrating singly to the coast at right angles and ending at a rail-head at a small port or fishing village. The shores of Cardigan Bay provide an example, their northern stretches as far south as Aberystwyth having a railway parallel to the shore, but their southern stretches being penetrated only by single lines isolated from each other.

The varying regional density of the rail net, however, does not reflect with complete accuracy the varying regional density of traffic or of population, for railway lines vary greatly in the volume of their traffic. To some extent this variation is registered by variation in number of tracks. A single-track railway, with loops at stations to permit trains running in opposite directions to pass each other, is characteristic of areas with little traffic and is common in rural districts such as East Anglia and West Wales. The industrial and urban districts of Britain invariably have double-track railways whose traffic capacity is more than twice that of single-track railways, for the slowing down or waiting for another train to pass does not arise.

Railways having a high density of traffic, such as main lines and lines carrying heavy industrial and holiday traffic, have not infrequently four tracks which have in turn a carrying capacity more than twice

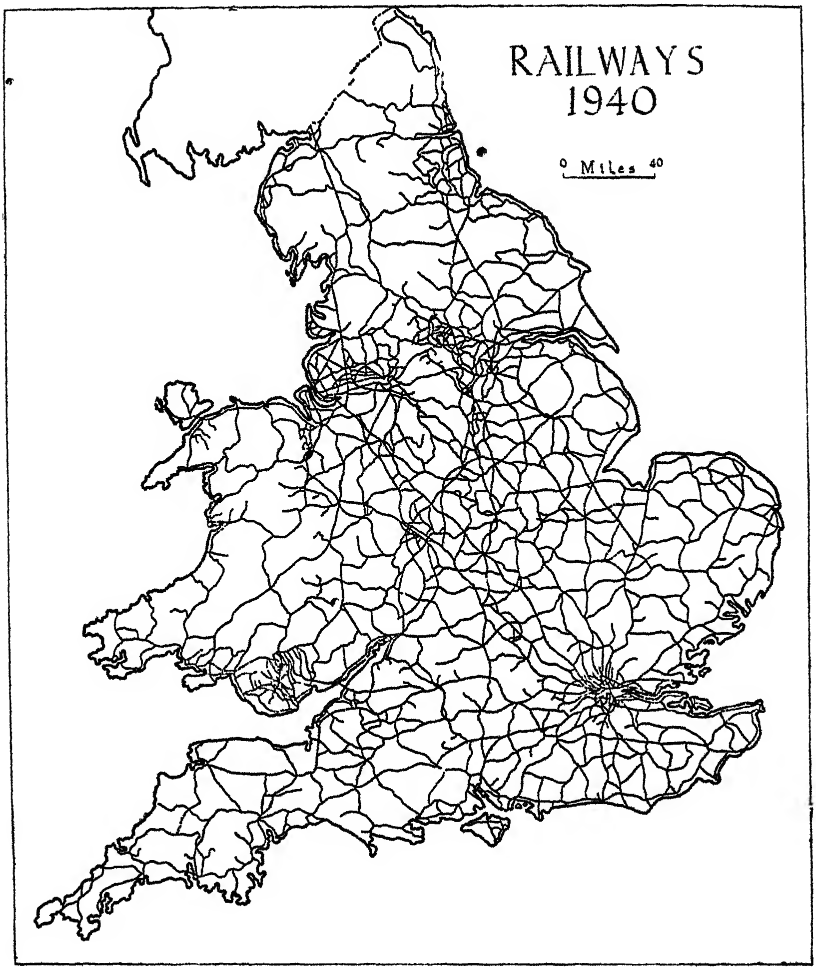

Fig. 82

RAILWAYS IN ENGLAND AND WALES IN 1940

that of the double-track railways. A quadruple track permits the separation of slow and fast traffic, and it is no longer necessary for a slow train to be directed to a siding to enable an express to get through. There still remains, however, some variation in density between individual lines within the same category.

The detailed distribution of railway traffic over Great Britain is

not easy to investigate. It is true that published railway statistics are of great value and permit a thorough traffic analysis. But the unit for which returns are made prior to nationalization was the company or, at best, an area within the company's system. Returns are not available for individual routes from, say, London to Southampton or Manchester to Liverpool. It is such detail which the geographer requires. This difficulty was aggravated by the amalgamations consequential on the 1921 Railway Act, for, although the traffic entries were more detailed and permit a more exact analysis, the number of companies and consequently of separate units for which statistics were given was reduced. The relationship between the geographical character of the region and its railway traffic was most clearly displayed by some of the smaller, more localized companies, covering a restricted but homogeneous economic region. The larger general companies included within their territory several types of economic region whose separate characteristics were masked in the aggregated returns. I should have liked, if space had been available, to analyse the railway traffic of those many small companies existing prior to the 1921 Act which coincided with homogeneous economic areas. I have prepared such an analysis for 1913. But I will confine myself here to an examination of traffic as it was developed in 1938, on the eve of the late war, and in 1950, the latest available year of the returns of British Railways. Tables XCVII and XCVIII have been calculated from the *Railway Returns for 1938* and from *Transport Statistics* together with the *Reports* of the British Transport Commission, to display the regional railway traffic of Great Britain so far as the areal arrangement of the returns will permit. The operating statistics have been calculated so that they are comparable for the two sample years.

The Southern Region stands out from the rest. It inherits the former Southern Railway, itself formed out of the London and South Western, the London Brighton and South Coast, and the South Eastern and Chatham, which in 1913 had presented comparable qualities sharply distinguished from the generalized characteristics of British railways as a whole. The Southern has a lower proportion of single track and of sidings, a higher proportion of double track, double the coaching train engine mileage, but half the freight engine train mileage of Great Britain. These proportions display most clearly the predominance of its passenger traffic. Its goods trains, moreover, are not only fewer per mile of road, but also consist individually of fewer wagons, each with a smaller average wagon load than on the

[1] The operating regions subsequent to 1 Jan. 1948, are the Scottish, including all lines north of the Border; the Eastern and North Eastern, sub-divisions of the former L. and N.E.R.; the Southern, the former S.R.; the Western, the former G.W.R.; the London Midland, the English sections of the former L.M. and S.R. There are discrepancies in the general coincidence of new regions and former companies, but the above gives their general content.

other main-line companies: the average freight train load is conspicuously smaller, being 123 tons in 1950 as compared with a national average of 157 tons. There was in 1938 a higher level of freight charges per ton-mile on general merchandise and on coal than on the other main-line companies, due partly to lower length of haul in these commodities in that year and partly to the non-industrial character of the territory served, for goods for direct home consumption can bear higher transport charges than goods in the course of manufacture or goods designed for export. While goods transport is thus small and expensive, passenger traffic is the heaviest of all regions, both in ordinary, workmen's, and season bookings. The excess is most marked in respect of workmen's and season bookings; that is, of daily travellers moving between residence and workplace. The Southern, in fact, does carry a very heavy suburban and residential traffic. The average receipt per passenger journey of workmen's and season bookings, though not of ordinary bookings, was in 1938 in excess of the national average, which, if standard passenger fares per mile be assumed for all companies, implies rather longer distance travel on the part of the workmen's and season bookings on the Southern than on the other companies. The removal of residence and workplace would thus appear to be rather more developed in the territory of the Southern than in the territory of the other regions taken in the aggregate. The ring of seaside towns around the Kent, Sussex, and Hampshire coasts are in large measure suburban to London, and travelling to and from them doubtless increases the average length of journey per passenger in the region as a whole. The great importance of passenger traffic is displayed in the high proportion of receipts from passenger trains to total traffic receipts—78 per cent in 1938 as compared with the national average of 46 per cent.[1] It is thus established that the traffic on the Southern reflects the non-industrial residential character of the territory the railway serves. The point may be developed further by an examination of the commodity traffic statistics. The density per mile of road of each of the four main categories of freight traffic is less in the Southern region than in all other regions, but the deficit is least in general merchandise, classes 7–21.[2] On the Southern Railway general merchandise contributed in 1938 a greater percentage of total goods traffic and of total goods receipts than on any of the other companies. This does not mean that the Southern region territory is a manufacturing region. A deficiency in coal traffic is due to lack of coal-mining and to lack of coal-using industry, for the coal carried

[1] Passenger train receipts include receipts from parcels and mails as well as from passengers. Apart from the Southern Railway, these constitute an even percentage of passenger train receipts, varying between 24 and 26 per cent, but on the Southern Railway they were only 13·5 per cent. This lower percentage is due not to a lower density of parcels and mails per mile of road, but to the very heavy passenger traffic.

[2] General merchandise, classes 1 to 6, consists of heavy low-grade commodities.

TABLE XCVII

A

Traffic Statistics of the Main Line Companies, 1938

	S.	G.W.	L.M. & S.	L. & N.E.	Great Britain
Road mileage open for traffic	2,156	3,782	6,845	6,349	20,007
Total track mileage	5,424	9,067	19,522	16,812	52,357
Percentage of road mileage:					
Single track	27	48	33	38	38
Double track	65	43	55	54	53
More than double track	8	9	12	8	9
Per road mile in hundreds:					
Coaching engine train miles	296	114	151	117	144
Freight engine train miles	32	96	81	73	67
Wagons per freight train:					
Loaded	21	23	23	22	22
Empty	10	11	11	12	11
Average freight train load in tons	101	130	124	129	125
Average wagon load in tons:					
Merchandise (classes 7–21) inc. livestock	2·7	2·9	2·8	2·8	2·8
Merchandise (classes 1–6)	8·6	9·5	9·8	10·0	9·8
Coal and coke	9·4	10·6	9·3	10·0	9·8
All freight	4·9	5·7	5·3	5·8	5·6
No. of passengers per road mile in hundreds:					
Ordinary	754	214	319	234	302
Workmen	343	74	132	75	122
Season	600	120	180	120	180
Tonnage per road mile in hundreds:					
Merchandise (classes 7–21)	22	33	38	31	22
Merchandise (classes 1–6)	11	25	37	35	24
Coal and coke	38	112	106	124	86
Livestock	2	5	8	6	4
Average length of haul in miles:					
Merchandise (classes 7–21) inc. livestock	52	76	77	74	107
Merchandise (classes 1–6)	50	55	52	46	64
Coal and coke	35	35	41	36	45
Receipts per road mile in £ hundred:					
Total traffic	101	70	93	73	82
Passengers	60	22	30	20	29
Merchandise	21	39	52	45	43
Parcels and mails	11	8	10	7	8
Percentage of traffic receipts:					
From passenger trains	78	43	43	38	46
From freight trains	22	57	57	62	54
Percentage of goods receipts:					
Merchandise (classes 7–21)	54	48	47	42	46
Merchandise (classes 1–6)	11	13	15	14	14
Coal and coke	34	37	37	43	39
Livestock	1	2	1	1	1
Average receipts per ton-mile of freight traffic in pence:					
Merchandise (classes 7–21)	2·5	1·9	2·0	1·9	2·0
Merchandise (classes 1–6)	1·0	0·9	1·0	0·9	1·0
Coal and coke	1·4	0·9	1·1	1·1	1·1
All freight	1·7	1·2	1·4	1·3	1·3

B

Traffic Statistics of the Regions of British Railways, 1950

	London Midland	Western	Southern	Eastern	North Eastern	Scottish	Great Britain
Road mileage open for traffic .	4,677	4,022	2,270	3,090	1,922	3,591	19,573
Total track mileage	14,796	9,883	5,692	8,734	5,554	7,467	52,126
Percentage of road mileage:							
Single track .	23	47	28	31	32	56	37
Double track	61	43	64	58	58	41	53
More than double track .	16	10	8	11	10	3	10
Per road mile in hundreds:							
Coaching engine train miles	133	104	269	124	79	66	124
Freight engine train miles .	98	63	33	87	77	57	71
Wagons per freight train:							
Loaded	26	25	21	22	21	19	23
Empty	10	8	9	12	8	6	9
Average freight train load in tons	175	163	123	167	151	113	157
Average Wagon load in tons:							
Merchandise (classes 7–21) inc. livestock	3·6	3·8	3·4	3·8	3·9	3·8	3·7
Merchandise (classes 1–6)	11·6	10·2	9·2	11·3	10·8	9·5	10·7
Coal and coke	10·3	11·2	9·8	10·3	13·5	10·1	10·7
All freight	6·8	6·6	5·6	7·4	7·1	5·8	6·8
No. of passengers per road mile in hundreds:							
Ordinary .	254	151	707	247	160	100	247
Workmen . .	136	51	340	125	57	28	113
Season	92	64	599	149	49	49	142
Tonnage per road mile in hundreds:							
Merchandise (classes 7–21)	35	25	15	25	40	21	27
Merchandise (classes 1–6)	42	22	7	34	60	22	31
Coal and coke	104	68	15	86	21	54	85
Livestock .	0·5	0·5	0·1	0·2	0·5	1·0	0·5
Average length of haul in miles:							
Merchandise (classes 7–21) inc. livestock	141	134	99	137	99	129	129
Merchandise (classes 1–6)	87	107	137	106	43	66	83
Coal and coke	81	65	110	85	23	42	61

Notes: (1) Tonnage in 1938 is tonnage conveyed and the same truck load travelling on more than one company's system appears in each company's traffic. These on repetitive entries are most frequent in general merchandise (classes 7–21).

(2) Mileages in the second part of the table refer to 1949.

in the region is very largely for domestic, gas plant, and electricity power station consumption. General merchandise is carried not between industrial establishments in the course of manufacture, but to the consumer after manufacture. Having a large residential population, the Southern region has a large demand for consumer goods. A large proportion of general merchandise to total goods traffic is common to railways serving non-industrial districts and particularly non-industrial residential districts.

The other companies in 1938 and other regions in 1950 present a much better balance between passengers and goods. In 1938 on each, receipts from freight trains exceeded receipts from passenger trains and receipts from passenger trains themselves included substantial earnings, amounting on these companies in 1938 to one-quarter of the total, from the carriage of parcels and mail. It is possible, however, to distinguish in 1938 between the London Midland and Scottish, on the one hand, and the Great Western and London and North Eastern on the other, and in 1950 between the London Midland and the Eastern, on the one hand, and the rest on the other.

The London Midland and Scottish had a heavier goods and passenger traffic per mile of road than either the Great Western or the London and North Eastern. It had also, as might be expected to follow from this greater traffic density, a smaller proportion of single-track mileage and a larger proportion of mileage with more than two tracks. It had a greater number of coaching engine and freight engine train miles alike. The London Midland and Scottish was the railway of industrial and urban Britain—of Lancashire and Yorkshire, the Midlands, and the West of Scotland. But, while it had a greater density of loaded freight wagon miles, its density of empty freight wagon miles was exceeded by the London and North Eastern, and its density of shunting engine miles was equalled by the Great Western. A high density of empty goods trains is characteristic of a coal-exporting district[1] and a high density of shunting engine mileage is characteristic of dock work. The density of goods traffic was not greater on the London Midland and Scottish than on the other two companies for all categories of commodities; it was greater for general merchandise, classes 1–6 as well as classes 7–21, and for livestock, but it was less for coal in respect of tonnage, though not in respect of ton-mileage. The Great Western and the London and North Eastern had both in 1938 a large coal export trade which, from the South Wales and the North-east Coast coalfields, is a relatively short-haul business: this coal export would increase the total tonnage to a greater extent than the ton-mileage. It follows from the above that merchandise, of all classes, constituted a greater and coal a lower, proportion of total freight traffic on the London Midland and Scottish than on the other two main-line companies.

[1] Empty wagons returning from the port of export to the pit.

While the London Midland and Scottish territory was very largely that of industrial Britain, particularly of those districts with a varied manufacturing activity, the Great Western and London and North Eastern territories included large stretches of rural country, and their industrial districts, themselves comparatively restricted in extent, were concerned with mining and heavy iron and steel rather than with general manufacturing. Industrialism on the North-east Coast is not identical with industrialism in Lancashire, the West Riding of Yorkshire, or the West Midlands. Compared with the London Midland and Scottish, they each had a lower density of traffic, particularly of passenger traffic, and they each had a larger proportion of their mileage in single track. Their passenger traffic was lower in density in all categories. But their goods traffic more nearly approached the density of that on the London Midland and Scottish and exceeded it in coal tonnage, though not in coal ton-mileage. Coal export from South Wales in Great Western territory, and from the North-east Coast in London and North Eastern territory, was responsible for this heavy coal tonnage with the relatively short average hauls in 1938 of 35 and 36 miles respectively. The heavy character of the goods traffic of the Great Western and of the London and North Eastern was reflected in a greater average wagon load and in a greater freight train load than on the other main-line companies. The greater average wagon load was particularly true of coal, and high wagon loads of coal were to be expected in coal-exporting districts. The London and North Eastern, moreover, had a greater number of high-capacity wagons than the other main-line companies, and it was this company which had the highest average wagon load for other minerals.[1] The railway companies of Britain, however, then owned little more than half the total wagons running on their systems.[2]

The regions employed since nationalization for railway administration and for the assemblage of traffic returns are a little more useful for the geographical analysis of traffic than the companies created by the Act of 1921. Apart from the Southern region already

[1] It will be noticed that on all companies and regions the average wagon load for general merchandise (excluding classes 1–6) is much smaller than the average wagon load for coal or low-grade merchandise. Some of this is due to commodities which fill a wagon in cubic space, but which weigh light, but most is due to the small size of the average consignment—in 1926, on the London Midland and Scottish, of only 5–6 cwt. If such small consignments were held back by the railways until a sufficient number were accumulated for the same destination, it would mean great delay to the trader and the company would be likely to lose future traffic of this kind to the road.

[2] Writing in 1928, W. V. Wood gave the number of wagons as 721,000 owned by the railway companies and 600,000 owned by traders, 550,000 of the latter being for coal traffic (W. V. Wood, *Railways* (1928), p. 83). The Summary Table of Statistical Returns for 1945 (Ministry of Transport) give the available number of railway-owned wagons in 1938 as 645,000 and in 1945 as 609,000, and the available number of requisitioned private owners' wagons in 1945 as 529,000. Stock owned by British Railways at the end of 1949 consisted of 1,099,000 wagons and trucks.

considered, they fall into two groups, the London Midland and Eastern on the one hand and the Western, North Eastern and Scottish on the other. The first group handles the traffic of most of the industrial Midlands and industrial Lancashire and Yorkshire, and the suburban traffic of the northern sector of Greater London. Although the Western handles some London traffic, it is dominated by Wales and the West Country, the North Eastern is dominated by the North-east Coast and the Scottish by industrial Scotland; but all these include large areas of rural country and they have, in fact, a large proportion of their mileage in single track, especially upland Scotland and Wales. The low level of coal traffic in these regions where it was once so high must be a reflection of the decline of coal shipment overseas. It will be noticed that length of coal haulage is least in those areas with coalfields near the coast than it is elsewhere in the country. The 'industrial' group has a higher density of traffic, of both passenger and freight trains, but this higher density is particularly pronounced in all categories of passenger traffic. The Western, the North Eastern and especially the Scottish regions have indeed a very light passenger traffic in relation to their road mileage.

Owing to changes in the areas for which traffic returns are now made, it is not possible to make any exact regional comparison of traffic in 1950 as compared with 1938. Certain conclusions can, however, be drawn for the country as a whole. Road mileage has fallen slightly, a fall expressed chiefly in the closing down of single track lines. Coaching engine train mileage has fallen but freight engine train mileage has increased: number of passengers has declined but tonnage of freight has grown. The fall in passenger traffic appears to have been least in the Southern region, where fast suburban traffic has been so elaborately developed, and it has been least in early morning and workmen's bookings. There has been some improvement in efficiency of loading of freight trains, on the evidence of increase in load per wagon: but against this must be set some decline in the efficiency of loading of passenger trains, if the greater percentage decline in number of passengers than in coaching train mileage be indicative of such decline.

The *Railway Returns for 1938* give some traffic statistics for sub-areas of the Great Western, London Midland and Scottish, and London and North Eastern.[1] These enable the picture of railway

[1] The sub-areas of the Great Western were (*a*) the Western, the territory south of Swindon; (*b*) the Midland, the territory north of Swindon; and (*c*) the South Wales, which extended into Pembrokeshire. The sub-areas of the London Midland and Scottish were (*a*) the Western, (*b*) the Central, and (*c*) the Midland, which were approximately the former territories of the London and North-Western, the Lancashire and Yorkshire, and the Midland, together with two areas in Scotland, (*d*) the Southern, between Carlisle and Stirling; and (*d*) the Northern, north of Stirling. In the amalgamations consequential on the Act of 1921 the London Midland and Scottish absorbed the Caledonian, the Glasgow and South-Western, and the Highland Railways. The sub-areas of the London and North Eastern were

traffic to be drawn in a little finer detail. Selected traffic statistics for these sub-areas are set out in Table XCVIII, but for many traffic returns separate particulars for these sub-areas are not available, and it is not possible to delineate the characteristics of their traffic at all completely. These sub-areas were not distinguished in 1950.

The returns of average freight train load display some interesting and significant differences. The lowest loads were in the two northern Scottish areas, that of the London Midland and Scottish north of Stirling and that of the former Great North of Scotland Railway, with train loads in 1938 of 74 and 54 tons respectively, as compared with the national average of 125 tons. The steeper gradients are no doubt partly responsible, but they cannot be wholly responsible, for the former Great North of Scotland's territory was the lowland and low hill country of North-east Scotland. The low densities of traffic in these northern rural areas which provide few goods for railway transport must also be partly responsible for the low freight train loads recorded. It may be that low density of traffic is the more important factor. The highest average freight train loads were on the South Wales section of the Great Western, the Midland section of the London Midland and Scottish, and the Southern (western) section of the London and North Eastern. Each of these served an industrialized region with a dense traffic. It might be expected that the equally industrialized sections of the Western (former London and North Western) and Central (former Lancashire and Yorkshire) of the London Midland and Scottish and the North Eastern section of the London and North Eastern would also have high average freight train loads, but the latter had much rural country, as well as a coalfield, within its territory, and the Western and Central sections of the London Midland and Scottish had a great deal of short-distance traffic between contiguous urban areas which presumably tend to encourage lighter, if more frequent, trains. There was comparative uniformity in the wagon load in respect of coal, except that it was considerably greater in the South Wales section of the Great Western and the North Eastern section of the London and North Eastern, that is, the coal-exporting districts with a specialist bulk traffic. Wagon load of coal was considerably less than the average only in the two northern Scottish districts. In mineral traffic other than coal, the greatest wagon loads were in the Midland section of the London Midland and Scottish and in the Southern (western) and North-eastern sections of the London and North Eastern; each had a considerable traffic in iron ore and bulk limestone.

(*a*) the Southern (Eastern), (*b*) the Southern (Western), (*c*) the North Eastern, (*d*) the Southern Scottish, and (*e*) the Northern Scottish, which corresponded approximately to the former territories of the Great Eastern, the Great Central and Great Northern together, the North Eastern, the North British, and the Great North of Scotland respectively.

There were returns of individual commodities for each of these sub-areas as for the main-line companies as a whole. Percentages have been calculated for several commodities and incorporated in Table XCVIII, but there is not space here to examine each in turn. I will consider the traffic in agricultural produce as a sample. The traffic in vegetables and potatoes is greatest in those areas which include much rural territory. The Southern (eastern), the Southern (western), and the North-eastern sections of the London and North Eastern had, in 1938, 40, 11, and 10 per cent respectively of the traffic in vegetables other than potatoes; between them these areas cover the arable districts of eastern England. The rural sections of the Great Western had a not inconsiderable traffic in vegetables, but the London Midland and Scottish handled little business of this kind. The intensively farmed arable district of South-west Lancashire, with its bulk production of vegetables for urban markets, sends much of its output over the short distances involved by road rather than by rail. The traffic in potatoes is more concentrated, just as potato-growing on a large scale is more concentrated. The eastern districts again handled the greatest quantities, but it was the Southern (western) rather than the Southern (eastern) section of the London and North Eastern; that is, the Fenland and Lincolnshire rather than East Anglia, which handled the greatest bulk. The potato-growing districts of South Lancashire contribute as little to railway traffic in potatoes as in other vegetables. But the Scottish districts contribute a great deal, and this refers not only to the Lothians and Ayrshire, but also to the seed-potato districts farther north. The section of the London Midland and Scottish north of Stirling contributed in 1938 no less than 12 per cent of the potato traffic of all British railways, though its total goods traffic was no more than 1·2 per cent of the total of Great Britain. The sugar traffic is again chiefly in those sections serving eastern England, the three English sections of the London and North Eastern handling 16, 18, and 15 per cent of the total sugar traffic. The greater part of this is from the beet-sugar factories. But there was a substantial sugar traffic on the Midland section of the Great Western, and on the Western and southern Scottish sections of the London Midland and Scottish and on the southern Scottish section of the London and North Eastern: this is doubtless traffic associated with the sugar refineries of Merseyside and of Clydeside. The traffic in grain, flour, and offals, like that in sugar, is affected by the port industries as well as by the grain-growing districts within Britain, and it is affected by the ubiquity of the market for flour which comprises the whole population of the country. The largest quantities were handled by the Western section of the Great Western, which served the Avonmouth mills, and by the North-eastern section of the London and North Eastern, which served Hull. Somewhat lesser quantities were handled by the South

TABLE XCVIII

Traffic Statistics for Areas within Main Line Companies, 1938

	G.W			L.M. & S.					L. & N.E.				
												Scottish	
	Western	Midland	South Wales	Western	Central	Midland	Northern (S)	Northern (N)	Southern (E)	Southern (W)	North-eastern	S.	N.
Percentage of goods ton-mileage in the area:													
Merchandise (classes 7–21) and live stock	41	36	20	40	23	23	44	43	29	20	37	36	49
Merchandise (classes 1–6)	18	25	12	24	11	20	21	12	17	22	18	17	18
Coal	41	39	68	36	66	57	35	45	54	58	45	47	33
Average freight train load in tons	120	118	154	123	108	141	105	74	117	149	122	105	54
Average wagon loads in tons:													
Merchandise (classes 7–21) and live stock	2·6	2·7	4·3	2·9	2·6	2·5	3·4	2·4	2·7	2·6	2·9	3·1	2·7
Merchandise (classes 1–6)	9·3	9·8	9·5	9·9	8·8	10·2	8·9	9·0	9·1	10·4	10·4	9·1	7·6
Coal	9·7	9·9	11·5	9·2	9·3	9·4	9·1	8·6	9·3	9·6	12·7	9·0	8·6
All freight	4·6	5·0	8·4	5·0	5·7	5·8	5·2	4·0	5·4	6·3	5·6	5·4	4·1
Wagons per freight train	25·9	23·6	18·2	24·9	18·9	24·4	20·1	18·3	21·8	23·7	21·8	19·4	13·3
Percentage of tonnage of in Great Britain:													
Iron ore	—	6	3	17	—	18	5	—	—	26	20	4	—
Pig iron	—	1	14	17	—	17	19	—	—	6	18	6	—
Scrap	3	3	8	15	3	9	18	—	2	11	13	6	—
Iron and steel	1	3	15	11	1	10	15	—	1	13	22	3	—
Limestone for blast furnaces	—	1	10	14	—	23	4	—	—	5	39	4	—
Grain, flour, and offals	17	2	9	7	1	6	3	—	9	4	15	9	1
Oil cake	17	5	—	43	—	5	1	—	5	1	16	1	—
Bricks, etc.	1	4	4	23	4	8	7	—	7	27	5	6	—
Paper	13	—	2	13	7	7	5	—	1	8	10	12	4
Sugar, etc.	2	7	3	10	—	3	11	—	16	18	15	8	—
Limestone and chalk and lime in bulk	—	2	3	13	—	53	2	—	—	5	18	1	—
Potatoes	—	1	—	1	2	1	5	12	14	29	4	13	1
Vegetables other than potatoes	4	6	1	2	2	2	1	1	40	11	10	4	—
Mining timber	—	1	38	9	—	—	3	1	—	3	34	7	1
Other timber	5	2	7	27	1	3	5	2	2	6	23	6	—

From *Railway Returns for 1938.*

Wales section of the Great Western, by the Western section of the London Midland and Scottish, which included Merseyside, by the Southern (eastern) section of the London and North Eastern, which covered East Anglia, and by the southern Scottish section of that railway, which included the Lowlands and Leith. The flour from the Thames-side and Merseyside mills is distributed largely by road and does not enter into railway traffic, but the Hull and Avonmouth mills, in urban areas, but in the midst of rural country, contribute extensively to rail traffic. Of the traffic in oil-cake, three-quarters of the total was on the Western sections of the London Midland and Scottish and Great Western, and on the North-eastern section of the London and North Eastern, which carried the traffic of the oil and cake mills of Merseyside, Bristol, and Hull respectively.

The above analysis has shown how intimately railway traffics are modelled by economic geography. It would be of great interest to investigate the reverse side of the relationship, the effect of the railway on the location of industry and of the industrial population. When asked a question along these lines by the Barlow Commission, Sir Ralph Wedgewood declared that the effect of the railway on the *regional* distribution of industry, apart from its local siting, was limited to the general cheapening of transport which 'enabled a greater dispersion to take place, or a greater concentration, according to the needs of industry'.[1] In Great Britain the railway has mostly followed industry, it was declared and with truth, rather than industry the railway, for the railway arose within a previously defined industrial environment. This has not been so in colonial territories, like Canada or the United States when the railways were first being built, for lines were pushed on ahead even of population. The implication, if I understand the contention rightly, is that the cheapening of transport which resulted from the railway during the nineteenth century permitted industry to be located at greater distances from its raw materials and from its markets than hitherto, and that, as pointed out in the historical chapters of this book, regional specialization of industrial production could develop on a large scale. 'Thus,' in the words of the *Report* of the Barlow Commission, 'it may be said that railway development removed, or partly removed, the obstacle to the regional specialization and concentration of industry'. Alfred Weber makes the same point.

But the railway has effects on the distribution of industry by reason of its methods of rate charging, in addition to this general effect of the cheapening of the costs of transport, though these effects are difficult to trace and were not admitted by the Railway Companies Association in its *Evidence* before the Barlow Commission. They are, however, quite generally assumed. Thus, in discussing the rates structure of the railways based on values, Sir Osborne Mance reports

[1] Barlow Commission, *Minutes of Evidence*, Q. 5664.

that 'several countries . . . have definitely decided that the existing railway rates structure is essential for the maintenance of the present distribution of industry'.[1] British railway history is strewn with complaints of undue preference, not only of one trader at the expense of another, but also of the access of different traders in different districts to a common market, that is, of one district at the expense of another. The nineteenth century did not doubt the reality of this inter-trader and inter-district competition owing to special rates. There was endless argument, and litigation, about undue preference, about inequality of rates for identical lengths of haul, about short hauls being charged more than long hauls on the same route.[2]

In the United States the basing point system of rate charging encouraged the aggregation of industry at the basing points and the denudation of industry from the intermediate points.[3] The basing point system, however, has not been developed in Britain. Somewhat the reverse has arisen in the form of group rates on particular specified commodities whereby, to give an example, a group rate from stations on Teesside to stations in South Staffordshire would permit the same rate from Stockton or West Hartlepool to Dudley or Birmingham.[4] There is a group rate on coal from the South Yorkshire field to London, the cost of conveyance being identical from every pit in the district. The effect of such group rates is presumably to create uniform railway costs *within* a particular industrial area. This doubtless still further encourages the development of industrial regions and the diffusion of industry within them as distinct from individual industrial towns and the aggregation of industry around a particular point. Such industrial regions, of course, are primarily created by other factors, such as those discussed in earlier chapters.

Let us look at a second feature of railway rates structure, that of tapering rates. British standard railway rates have long had a taper whereby the conveyance rate, as distinct from the terminal charges, which are the same whether the distance over which the goods are conveyed be 10 or 100 miles, become progressively less per ton-mile as the length of haul increases.[5] Tapering rates encourage long-distance hauls and have permitted individual factories to extend the geographical range of their activities, to draw in raw materials from farther afield and to distribute their finished products more widely. Tapering rates have intensified still further the locational effects of the cheapening of rates considered above. The effect, however, is

[1] Osborne Mance, *The Road and Rail Transport Problem* (1941), p. 20.
[2] J. S. Jeans, *Railway Problems* (1887), p. 288.
[3] W. Z. Ripley, *Railroads: Rates and Regulation* (1916). Chaps. VII and XI.
[4] Barlow Commission, *Minutes of Evidence*, Q. 5649.
[5] For goods in class 6 of the General Railway Classification the standard rates per ton, station to station, in 1938 were 1*s*. 9*d*. terminal charges irrespective of distance, plus a conveyance charge of 2*s*. 3*d*. for 10 miles, 8*s*. 2*d*. for 50 miles, 12*s*. 9*d*. for 100 miles, and 19*s*. 9*d*. for 200 miles, giving a ton-mileage rate decreasing with distance.

more pronounced in respect of those industries handling the more valuable goods, for these can bear the costs of long hauls despite the higher rates which the railways charge on more valuable commodities. The Balfour Committee, for example, calculated that in 1925 railway rate charges as a percentage of export value were 9·2 per cent for coal, 4·2 per cent for pig iron, 1·8 per cent for steel ingots, and 0·9 per cent for machinery. This differential burden of transport charges on industry fixes the location of some industries more closely than of others.

Only a small proportion of railway traffic is conveyed by standard rates.[1] Sir William Ackworth put it this way. 'Our mileage rates, speaking broadly, only touch the retail business of the country. The wholesale traffic, the large consignments, the constant interchange between great centres, the export, import, and transit trade—all this is done at what are called "special" or "exceptional" rates.'[2] There is one further method of rate charging which needs mention, the Agreed Charge, which developed rapidly during the 'thirties. The geographical significance of the method can only be appreciated after a long explanation. It may be stated summarily, however, that Agreed Charges would perhaps give temporary advantages to a factory as compared with a competitor whose traffic was carried at ordinary rates, but the advantage would disappear on the re-assessment of the Agreed Charges. Only if the onset of competition was so severe that competitive factories were closed down within a few months, would effects on the location of industry develop.

Whatever the effects of the railway on the regional distribution of industry, it has had marked effects on the precise siting of industry and of population. Railway services have permitted the divergence of residence from workplace and have permitted alike the growth of great urban centres and of residential towns removed from places

[1] Before 1928, when the present classification of commodities came into operation, it was no more than 20 per cent and was less than this for mineral traffic (Sherrington, op. cit., vol. II, p. 93). The new classification, comprising twenty-one classes apart from coal, is much more elaborate than the old, and it was expected that the number of exceptional rates would diminish. But although there was some initial decline they have since steadily increased owing to the effects of road competition. The proportions quoted by Dr. Walker for a sample week in March in each of the years 1928, 1930, and 1935 of traffic carried by standard rates were 33 per cent, 23 per cent, and 16 per cent respectively for tonnage and 50 per cent, 40 per cent, and 32 per cent respectively for receipts (G. Walker, *Road and Rail* (1942), p. 63). The differences in proportion according to tonnage and receipt displays that exceptional rates are lower than standard rates and that standard rates probably cover higher priced commodities than exceptional rates.

[2] W. M. Ackworth, *The Elements of Railway Economics* (1924), p. 135. The exceptional rate is an instrument whereby the railway can acquire new traffic which would be unobtainable at the standard rate. It is somewhat similar to the cheap passenger excursion and the bargain sale in retail shops in that it is intended to create new customers stimulated by the bargain. This was the object of the exceptional rate during the nineteenth century. The exceptional rate is also a means whereby the railway can retain traffic threatened by road competition, and this is its chief object at the present day.

of employment. Present-day road services permit the same outspread of population perhaps to an even more marked degree, but the process was begun by the railways long before. Population, especially suburban and seaside population, has grouped itself radially around the railway station. The population pattern dependent on rail transport is very different from the population pattern dependent on omnibus road transport, the one being radial around a point and the other linear along a route. Not all industry, however, has congregated itself along a railway or around railway sorting yards. A rail-side site is of maximum benefit when a factory has a private siding or equivalent facilities where goods can be loaded or unloaded direct between railway truck and factory. This minimizes cartage costs, for a factory away from the railway has to pay cartage to and from the goods station if goods are carried at the station-to-station rate. Not all factories, however, deal in commodities which can be handled in bulk direct from or to a railway truck, and a rail-side site may have disadvantages in other respects. For industries like coal-mining, iron smelting, steel-making, heavy engineering, gas-making, flour-milling, and the like, a rail-side site is of great advantage. For lighter industries it is not so necessary. Care must be taken when examining a large-scale map of industrial distributions not to make false inferences from factory sites adjacent to a railway line, for there are many factories lying alongside a railway but having no physical connexion with it. There are many such examples in Liverpool and, indeed, in every manufacturing town.

IV

ROAD TRANSPORT AND THE COMPETITION BETWEEN ROAD AND RAIL

The road is the third element in the transport system of Britain. I will consider first the plan of the road system and the pattern of road traffic, and then examine the relations between road and rail in order to discover their respective functions in the transport system as a whole.

The road is the most nearly ubiquitous of all means of internal communication. It is less sensitive to gradient than canal or railway, and road vehicles can surmount gradients of 1 in 6 or even 1 in 4, which would be impossible to the locomotive engine or canal barge. It is less expensive to construct and in its most primitive form is an earth road requiring no expenditure whatever. But road vehicles carry much smaller unit loads than either rail or canal, partly because of steep gradients and sharp curves, and partly for mechanical reasons. The road pattern of Great Britain, in fact, has grown gradually by use and, except for Roman roads, long-distance roads of the turnpike era and some modern trunk roads, has not been consciously planned.

It would be impossible even to try to describe the road pattern of to-day and only a few general points can be picked out.

The first is that the main trunk roads frequently coincide in direction and route to the trunk railways. Thus, A.6 and the London Midland and Scottish line through Rugby, Crewe, and Preston to Carlisle are strikingly parallel. The Great North Road and the London and North Eastern main line to Scotland provide another example. Routes with such long-distance objectives are dictated by topography and by the need to link particular places with each other, but it is nevertheless striking how close such long-distance road and rail routes are in country where the physique of the land is such that many alternative routes are open. This general coincidence in route between road and rail is by no means limited to the arterial routes. Every district provides examples. There is not, however, the same correspondence in the detail of the route. The railway keeps to the lower ground, even if it involves a more circuitous route, while the road frequently strikes across the higher ground. In lowland country the railway takes a straight course while the road, inheriting the lie of local lanes, may zigzag backwards and forwards across the railway.

The road pattern forms a very much closer network than the rail pattern. The area covered by settlement and the area covered by the road pattern are coincident. The only parts of Britain without surfaced roads are mountain country devoid of habitation, and even they may have through-roads designed for other than local need. Taking into account unclassified as well as Class I and II roads, but excluding private roads, the road pattern has few loose ends in the form of road-heads, and it is only in mountain valleys, as in Eskdale in the Lake District or at small coastal villages, such as Ravenglass on the Cumberland coast, where even these are to be encountered. There are, of course, innumerable road-heads in the form of occupation roads, but these do not usually have a hard surface and they are not part of the public road system of the country. The British road system thus presents a cellular structure permitting traffic between places in an infinite number of permutations and combinations. The closeness of the cellular tissue is up to a point a reflection of the density of population. In the built-up areas the distance apart of roads is measured in yards, in lowland rural country in fractions of a mile, and in mountain country in miles. But there is no constant ratio between road mileage and population, for the rural districts have a considerably greater road mileage relative to their population than have the built-up areas. On the other hand, rural roads are narrow, with a lower traffic capacity and a lower actual traffic density than wider roads in urban areas. The closeness of the road pattern has the important consequence that the road frontage accessible to road transport is many times greater than the railway frontage

accessible to railway transport.[1] This has results in the distribution of industry and of population which will be explored later. The detail of the road pattern is a mixture of old and new—new stems consciously designed in relation to present-day traffic which have been grafted on to an old stock which has grown year after year over many centuries with the minimum of conscious design. Hence, the alternation even along the main roads of the country of (*a*) broad highways, having smooth surfaces, two-way traffic in each direction and segregation of cyclists, with (*b*) narrow passages, having rough surfaces, single traffic streams and cyclists cheek-by-jowl with motor vehicles. Some new arterial roads have been designed independently of the old and make contact with the pre-existing pattern at only a limited number of junctions, the pre-existing roads being carried over or under the arterial roads. There are, indeed, certain similarities between such arterial roads and railways.[2]

Roads, like railway tracks, are not identical; they vary in width, in surface, and in the volume of traffic they carry. Roads are classified by the Ministry of Transport for purposes of grants-in-aid for maintenance and improvements in accord with their economic function, particularly in accord with their relative importance as arterial roads.[3] The cost of work on trunk roads has for some time been met by a greater proportionate grant-in-aid from the Treasury than for cost of work on local roads, for much of the through traffic on trunk roads has nothing to do with the parish or rural district or even with the county council, and the cost of the upkeep of such roads cannot in equity be laid upon the local residents. The recent Trunk Roads Act[4] reclassified roads from this point of view and almost doubled the mileage of those classified as trunk roads. The Ministry's classification of roads is somewhat comparable to a classification of railways according to number of tracks, for it gives some, but by no means an exact, conception of their traffic-carrying capacity.

Of the actual traffic on the roads there are no returns comparable to the returns of railway traffic, which the railway companies had a statutory obligation to make, but the Ministry of Transport takes a periodic traffic census at some thousands of points on Class I and

[1] There is a striking difference in respect of actual route mileage, the public roads as returned by the Ministry of Transport having nine times the mileage of the railway, but the difference is even more striking in respect of the number of points accessible. Railway passengers have access to trains only at railway stations, which are miles apart except in suburban areas, while road passengers have access to road vehicles every few hundred yards. Rail-side factories have access to the railway only by means of a siding, while road-side factories can frequently load or unload direct from the road though most have a yard or service road.

[2] A Report of a Departmental Committee set up by the Ministry of War Transport entitled *Design and Layout of Roads in Built-up Areas* (1946) gives a very useful account of road design.

[3] Mileage in Great Britain in 1937–8 was Class I and Trunk, 27,259; Class II, 17,037; Unclassified, 135,334. These are public roads as distinct from private and occupation roads.

[4] Trunk Roads Act, 1946, 9 and 10 Geo. VI, Ch. 30.

Class II roads. The census is spread over seven consecutive days in the August of the census year, and the record taken is the number of each class of vehicle passing the census point. Each class of vehicle is given an assumed average weight (vehicle plus load) and tonnages for each census point are calculated accordingly.[1] We can only guess at the total tonnage of traffic (that is, load apart from vehicle) using the roads.

The *Reports* on the Road Traffic Census, while they do not give a quantity of total traffic statistically comparable with that of the *Railway Returns*, do permit an analysis of road traffic as between different types of economic area and as between different parts of Great Britain. Charts of density of road traffic were printed in the reports on the earlier censuses and similar charts based on Ministry of Transport data have become a common feature of town-planning reports. The census reports contain detailed returns for sample points in four types of area: industrial, agricultural, residential suburban, and tourist. These enable valuable deductions to be drawn in respect of adaptation of traffic to type of economic area. Calculated as an average per census point, statistics for sample censuses are set out in Table XCIX. It must be remembered that the census points are all on main roads. Industrial and suburban areas have clearly a considerably greater density of traffic[2] than agricultural and tourist areas, the one set is urban and the other rural. This difference is what we should expect. The difference between the two sets of areas is under-emphasized rather than over-emphasized by the census: the urban census points are outside the county boroughs and exclude dock traffic,[3] so that they do not show urban traffic at its maximum, while the traffic on Classes I and II roads in rural areas is largely through traffic and gives much more than a rural density proper to rural conditions. This greater density of traffic in urban than in rural areas is true of all classes of traffic—passenger motor vehicles, goods

[1] Examples of the weights used in 1936 are as follows: motor-cars, 1·25 tons; motor-cars with trailers, 2 tons; four-wheel single deck motor omnibuses, 4·5 tons; six-wheel double-deck motor omnibuses, 9 tons; four-wheel motor lorries, 7 tons, four-wheel motor lorries with trailers, 12 tons; light horse vehicles, 1·25 tons. The weights employed in earlier years were not identical and motor-cars, for example, were larger and heavier in earlier years. It would not be possible without the installation of a weighing machine at each census point to ascertain the actual laden weight of each vehicle. While railway tonnages refer to actual weights, road tonnages refer to assumed weights.

[2] The phrase 'density of traffic' as used in this chapter is the tonnage (or number of vehicles) passing each census point per day. It is not identical with the index of traffic density employed in the *Report* on the 1928 Road Traffic Census, which expresses the degree of traffic congestion in respect of the space taken up by vehicles relative to the width of the road. The concern of the Ministry of Transport is with the extent to which the road is fully used and the extent to which the road is adequately constructed to bear the weight of traffic passing over it. This is an engineering rather than an economic problem.

[3] A special census of three sample dock roads was made during the twelve months 1928–9, and will be referred to later, but dock roads are excluded from the returns considered in this paragraph.

TABLE XCIX

Character of Road Traffic according to Type of Area. I

	As daily average per Census Point for a week in August								
	Number of vehicles			Aggregate laden weight of vehicles in tons			Average laden weight per vehicle in tons		
	Motor		Horse-drawn	Motor		Horse-drawn	Motor		Horse-drawn
	Passenger	Goods		Passenger	Goods		Passenger	Goods	
Class I, 1928									
Industrial . . .	2,669	769	139	5,146	4,172	181	1·93	5·43	1·31
Agricultural . . .	837	154	64	1,418	788	90	1·69	5·11	1·41
Suburban . . .	2,652	489	79	4,540	2,711	101	1·71	5·45	1·27
Tourist . . .	1,424	138	28	2,144	765	33	1·51	5·56	1·19
Class II, 1929									
Industrial . . .	733	275	83	1,429	1,170	113	1·95	4·25	1·36
Agricultural . . .	202	37	15	310	160	20	1·53	4·36	1·35
Suburban . . .	1,084	238	35	1,780	945	43	1·64	3·98	1·22
Tourist . . .	416	41	11	657	159	13	1·58	3·93	1·23
Class I, 1938									
Industrial . . .	4,641	1,385	46	9,185	5,745	81	1·98	4·15	1·75
Agricultural . . .	1,460	240	8	1,854	1,233	14	1·27	5·13	1·74
Suburban . . .	3,928	771	17	6,874	3,150	29	1·75	4·08	1·74
Tourist . . .	3,424	358	12	4,837	1,700	21	1·41	4·75	1·76
Class II, 1936									
Industrial . . .	1,021	442	44	2,039	1,817	11	2·00	4·11	1·62
Agricultural . . .	309	72	6	434	290	10	1·41	4·06	1·83
Suburban . . .	1,795	403	19	3,237	1,665	28	1·80	4·14	1·51
Tourist . . .	650	78	5	878	298	9	1·35	3·82	1·74

From *Reports* on the Road Traffic Census.

motor vehicles, and horse-drawn vehicles. In the later, though not as conspicuously in the earlier, censuses, there are differences between the urban and rural areas in average weight, and presumably in average size, of passenger motor vehicles, being larger in the urban than in the rural areas. In the urban areas passenger motor vehicles include more motor omnibuses than in rural areas, and this makes a very substantial difference in total tonnage, for a private car was estimated in the scales used for the 1935 and 1936 censuses, for example, to have a laden weight of 1·25 tons, a four-wheel single-deck motor-omnibus, of 4·5 tons, and a six-wheel double-deck motor omnibus of 9 tons. The average weight of all passenger motor vehicles in agricultural and tourist areas is so low as to permit only a small proportion of omnibuses.[1]

There are further differences between the two types of urban area and between the two types of rural area. In the industrial areas total weight of goods motor vehicles approaches more nearly to that of passenger motor vehicles than in the suburban areas. There is, however, wide variation between the individual census points and the samples selected by the Ministry of Transport are by no means uniform in character within each group. Of the industrial samples on Class II roads in 1929 and 1936, four or five out of twelve in each census had an excess of goods tonnage over passenger; by selection of sample an excess for the entire industrial group might have been obtained. A heavy goods traffic in industrial areas is to be expected, but it must not be forgotten that the same areas have a substantial passenger traffic of industrial workers travelling in omnibuses. The average weight of passenger vehicles in every census is greater in the industrial areas than in any others, indicative of a higher proportion of omnibuses to private cars. At a census point in Rhondda in South Wales in 1936, the average laden weight of passenger motor vehicles was 3·8 tons, which is not far below that of a small single-deck motor omnibus, with a laden weight of 4·5 tons. With occasional exceptions which may be wrongly classified in this group, the census points in suburban areas had each a passenger traffic in excess of goods traffic.[2] Nevertheless, the suburban areas of this sample had a very substantial goods traffic. Classes I and II roads in suburban areas, however, are main roads carrying inter-town traffic and, though passing through suburbia, do not by any means confine their traffic to that proper to suburbia. In the rural areas there is a general similarity in density of goods traffic, motor and horse-drawn, between agricultural and tourist areas, which shows

[1] The differences in average size of goods vehicles in different types of economic area are not consistent as between Class I and Class II roads. The inconsistencies in the late 'thirties are perhaps due to the large long-distance lorries being more prominent on Class I than on Class II roads in rural areas.

[2] Examples are Stretford, in the southern part of the Manchester conurbation, and Elland, a large industrial village in the West Riding.

that in these respects the tourist areas are comparable with the agricultural. On Class II roads it may be asserted that the agricultural and tourist areas are identical. They differ only in the density of their passenger traffic, which in the tourist areas is twice that in the agricultural. There is little variation in average size of passenger motor vehicle as between agricultural and tourist areas, and, as both are approximately similar to the average size of private cars, whose weight was estimated at 1·6 tons in 1928–9, and at 1·25 tons in 1935–6, it is clear that the passenger traffic of the tourist areas in the sample consists primarily of private cars. From this analysis of road traffic in different types of economic area, it is clear that the character of road as of rail traffic is modelled closely by the character of the area which it serves.[1]

The *Report* on the 1928 Census for Class I roads includes the results of a special investigation, including night as well as day traffic, and extending over a period of twelve months instead of seven days, for twenty-four census points selected as typical of eight different types of area: industrial, dock, agricultural, tourist, sporting, residential suburban, seaside, and inland watering-place. None of these twenty-four census points is identical with the points involved in the table just analysed. Table C includes average aggregated traffic for each of these eight types over the entire year. It is not possible to compare the daily densities shown in the two tables because of the complete lack of identity of the census points. The *Report* on the 1928 Census, however, compares the daily average of the August–September traffic of the twenty-four points in Table C with the daily average at the same points over the whole year. It appears that the August–September traffic is typical of the annual total in the industrial, dock, and suburban areas, but is considerably heavier than the annual traffic in all other areas. The industrial areas, according to the samples aggregated in Table C, have a considerably heavier goods than passenger motor traffic and a not inconsiderable night traffic. The industrial areas, according to the samples aggregated in Table XCIX, however, showed a heavier passenger than goods traffic. It is clear that the precise proportion between passenger and goods traffic varies greatly between one census point and another within an industrial area, and the particular figure obtained varies greatly with the composition of the sample. The dock areas show an even heavier goods traffic, of motor and horse-drawn vehicles together, and a much smaller passenger motor traffic, the ratio being of the order of 5½ : 1. It is

[1] The density of traffic on Class I roads taken as a whole is clearly greater than on Class II roads as a whole: this greater density is the basis of their classification as Class I roads. It will be noticed that the average weight, and presumably the average size, of motor goods vehicles is considerably larger in the tourist and agricultural samples on Class I roads, which carry long-distance goods traffic in large lorries, than on Class II roads in the 'thirties. In the industrial and suburban samples, there are large lorries on short distance traffic.

reasonable to expect this in a dock area. The dock areas are distinguished from the industrial areas by a high density of horse-drawn traffic. This is typical of dock work, horse-drawn vehicles being held to be more suitable than motor lorries for the short-distance traffic between boat and boat, boat and dock-side warehouse, dock-side warehouse and dock-side railway station. Dock work still provides a source of employment for the mature, heavy dray-horses used for farm work when younger and less strong. The agricultural and tourist areas both display a closer approach of the quantities of passenger and goods tonnage in annual than in August traffic, and it is reasonable to infer that the great excess of passenger motor traffic which they display in August is primarily a summer phenomenon. The sporting areas are identical with the agricultural in traffic densities except for a somewhat greater passenger density and for rather more traffic after 10 p.m. The predominance of passenger over motor goods traffic in suburbia is even more strongly emphasized in Table C than in Table XCIX. The suburban areas have the greatest night traffic of all, night passenger motor traffic per hour being more than a quarter of that during the day. The seaside traffic is highly individualized. It has a density of passenger traffic approaching that of suburbia and many seaside areas, in fact, are residential and suburban in a very real sense. They have also a high goods traffic density, presumably of vehicles transporting consumer goods to serve the residential and holiday population of the seaside towns.

TABLE C

Character of Road Traffic according to Type of Area. II

	Class I roads. Daily averages in tons per census point, 1928							
	Day				Night			
	Motor		Horse-drawn	Live stock	Motor		Horse-drawn	Live stock
	Passenger	Goods			Passenger	Goods		
Industrial	2,979	5,946	88	2	306	144	1	—
Dock	1,284	5,128	2,009	15	104	34	14	—
Agricultural	631	433	37	7	39	6	—	—
Tourist	1,133	505	16	3	44	7	—	—
Sporting	795	495	16	8	56	47	—	—
Suburban	6,877	2,701	90	5	926	52	1	—
Seaside	5,507	3,384	47	4	454	112	—	—
Inland Watering	2,108	685	23	4	138	37	—	—

From *Report* on the 1928 Road Traffic Census.

Day refers to the period 6 a.m. to 10 p.m. and night to 10 p.m. to 6 a.m. One of the dock examples, the East India Dock Road, was discarded, as this road handles trunk traffic from London into Essex as well as dock traffic, so that it does not present conditions typical of a dock area.

After this survey of road traffic in respect of its adaptation to regional economic character, I will now turn to consider the reverse side of the picture, the effects of road transport on the economic geography of Britain. Road transport is no creation of the twentieth century, but, before the advent of the petrol-driven engine, it was slow, being by horse-lorries or steam wagons for goods and by horse coaches or electric vehicles for passengers. Road traffic was circumscribed by this very slowness. During the nineteenth century it had become ancillary to the railway and concerned wholly with local traffic. The petrol-driven engine has created a major transport revolution, has greatly increased the speed and the range of road traffic, and has permitted long-distance as well as local traffic on the roads. The road has ceased to be simply ancillary to the railway and has become a competitor. It is now possible for industry to be diffused widely in remote rural areas equally with established industrial areas. Theoretically, it was possible for factories to be set up alongside the railway in equally remote rural districts, but there was always a marked practical deterrent in that, unless such a factory could furnish the railway with complete train loads, it would not obtain full benefit from railway facilities. A large establishment using raw materials obtained on the site could develop in such a rural area, but a small establishment dependent on raw materials from outside could not do so as satisfactorily. The road lorry handling a much smaller unit load than the goods train can serve small rural factories much more readily and frequently. Road transport thus permits a loosening of the industrial fabric. The effect of the greater mobility of site has been much more pronounced with the light than with the heavy industries and newly established light industries are frequently congregated along arterial roads, such as the Great West Road out of London and the East Lancashire Road out of Manchester and Liverpool.

The greater diffusion of industry and of population which road motor transport permits has not reached the extreme form of even dispersal over the face of the country. The town planner's nightmare of one vast urban sprawl covering the entire country is, in fact, never likely to be realized. There are groupings of industry and groupings of population consequential on road services. These are linear in form and are spread along the main roads peripheral to the existing built-up areas, that is, the so-called ribbon-building. Such sites possess access to arterial roads on which road goods transport, whether by a firm's own lorries or by hired public carriers, is easiest and most economical. Such sites also permit immediate access to public motor omnibus services running along main roads with greater frequency than along minor roads, if the minor roads possess such services at all. The cellular road pattern is thus acquiring along the main arteries a thickening of the cell walls. Every region of Britain

can display the contrast between the nuclear masses of houses congregated radially around the railway stations and the linear ribbons of dwellings along the main omnibus routes. In many parts of the country these linear ribbons of settlement are the product of the twentieth century, but in the industrial districts of eastern Lancashire and West Yorkshire such linear distribution linking up town with town long ante-dated the petrol-driven engine. Here it was partly topographical in origin owing to the valley floor and valley side distribution of population, and it was emphasized by the availability in the nineteenth century of electric tram services in such closely occupied areas where each town sent forth feelers towards its neighbours. Linear ribbons of settlement are not now limited to the interstices between towns in such close proximity.

Motor road transport is having a further effect on industrial location in respect of the range of distribution of the factory product. Large bakeries, which furnish an example of the point I have in mind, can serve a wider radius than previously, when they were limited to horse-drawn vehicles, and they can therefore grow in size. Increase in radius of distribution is still further facilitated if the bakery has access to an arterial road. A bakery's radius of distribution is fundamentally one of time, and, if a greater distance can be covered by motor vehicle than by horse-drawn van and on arterial than on local road within a given time, then the distance radius is increased. Merseyside bakeries are tending to move to peripheral sites for these reasons. But motor transport will not in practice permit the radius of distribution of the factory product, expressed in distance, to increase without limit, for the cost advantage of motor transport is over short and medium distances, especially those within a radius of 50–75 miles, as will appear shortly. The distribution pattern of industry which motor transport tends to develop, therefore, is one of factories along arterial roads serving an area with consumption goods within a radius of 50–75 miles. This is in contrast to the distribution pattern, which railway transport tends to develop, of factories grouped around nuclear points serving distant factories or ports with semi-finished commodities in bulk and distant places with consumption goods for distribution within a restricted radius of the railway station.

I come now to the place of the road, with the present structure of road traffic operated by the petrol-driven engine, in the transport system as a whole. Such road transport has certain well-defined characteristics, different in many respects from those of railway transport. It will be convenient to consider goods and passenger traffic separately.

In 1928 C. T. Brunner distinguished three distance zones, in each of which there was a different balance of advantage as between goods lorries and goods trains.[1] The first, or inner, zone consisted

[1] C. T. Brunner, *The Problem of Motor Transport* (1928), pp. 39–40.

of an area with an outer limit of approximately 50 miles radius from the garage and residence of the road operator. This distance permitted a haulier to cover the return journey in a single day and thus to avoid the cost of a night's lodging and garaging away from home. Over such a distance most vehicles would be loaded on the outwards journey, but would return empty. It was, moreover, it may be added, the sort of service which an owner-driver with a single lorry could satisfactorily develop. The second zone had a radius of between 50 and 100 miles, a distance which permitted a lorry to complete the outwards journey and unload at the destination in the course of a single working day, but which did not permit the return journey within that time. The expenses of a night's lodging and garaging had to be met, and, on account of this expense and of the costs of an empty return journey, the road operator could compete with the railway only if he could secure some return load for the whole or part of the distance. A firm owning several lorries could more readily undertake this trade than the single owner-driver, for it would have more facilities for obtaining return loads. The third zone had a radius of over 100 miles. This involved the road operator in still greater expense, and in 1928 such distances were covered only by those firms operating on a sufficiently large scale to have collecting and delivery depots or agents at a considerable number of points throughout the area served. This general distinction between the zones still holds good, though their definition in terms of mileage may be somewhat different with greater efficiency on the part of the vehicle and with better organization for obtaining return loads. The distinction between short-distance and long-distance motor goods haulage is an important one, both in respect of personnel employed and of place in the transport system of the country. A memorandum submitted by a Long-Distance Road Haulage Group to the Royal Commission on Transport defined it as covering 'distances in excess of 30 miles from the base from which such vehicles operate'.[1] For war purposes the Ministry of War Transport defined long-distance road goods transport as that covering 'distances of 60 or more miles',[2] but the Transport Advisory Council had in 1937 rejected as impracticable any distinction between long-distance and short-distance hauliers for the purpose of establishing road rates.[3] The 1947 Transport Act defines long-distance road haulage as 'the carriage of goods . . . for a distance of forty miles or upwards . . . in such circumstances that the vehicle is at some time during the carriage, more than twenty-five miles from its operating centre'.[4] The distinction between short and long haulage is now a matter of great public importance.

[1] *Minutes of Evidence*, Mem. 58, Royal Commission on Transport. In the course of questioning some comment was made on the lowness of this minimum.

[2] *Long Distance Road Goods Traffic*, Cmd. 6506 (1944).

[3] *Report on Service and Rates*, Transport Advisory Council (1937), p. 7.

[4] Transport Act, 1947, 10 and 11 Geo. 6, Ch. 49, Sec. 39 (2).

Owing to the absence of statistics of road traffic, the road hauliers not being required to make returns, it is impossible to discover the average distance over which goods are transported by road, but it is clearly a shorter distance than by rail. This is the experience of all countries and not only of Great Britain.[1] It was estimated by an official of the Great Western Railway in 1929 that within the area served by one of the main-line companies the road carried 57·8 per cent of the traffic up to 40 miles, but only 18·5 per cent of the traffic over 40 miles. Returns of transport costs of a firm of multiple grocers for a standard load, first published by *The Times* and reprinted by Brunner, are very informative in reference to this point.[2] They are set out in graphical form in Fig. 84.[3] According to this diagram it was cheaper at that date to carry by road for distances of under 75 miles and dearer for distances of over 75 miles. If the cost of returned empties be omitted from the railway charges, the balance of advantage changed at 50 miles. The road thus competed quite freely at that date with the railway for traffic travelling distances of under 50 miles, but it competed for traffic over distances greater than 75 miles only under special circumstances. The reasons for this greater cheapness of road traffic over the shorter distances are bound up with the nature of the two kinds of traffic. Railway short-distance traffic is expensive because of the high proportion terminal charges contribute to the total transport charge. Railway rates are made up of two elements: (*a*) terminal charges (for the use of station, for loading, unloading, covering, and uncovering), which are the same whatever the length of haul; (*b*) conveyance charges, which vary with the length of haul, though not arithmetically on account of tapering rates. For short-distance rail traffic the terminal charges may be greater than the conveyance rate, for long-distance rail traffic they constitute only a small proportion of the total rate.[4] For very short distances the railways are empowered to charge conveyance rates for a specified minimum distance, so that, for example, if it is six miles the conveyance rate for carriage over a distance of two miles is the same as for six miles.[5] This is a positive discouragement

[1] *Bulletin International Railway Congress Association*, vol. XIX (1937), pp. 1127–8. Nevertheless, there was some very long-distance traffic in convoys of Diesel lorries from North Italy to South Italy.

[2] Dr. G. Walker, op. cit., fig. 2, has a diagram for a wide range of commodities and for a great number of distances. It points to the same conclusion that the road is cheaper for the shorter, but dearer for the longer distances for many but by no means all classes of commodities.

[3] The standard load taken for comparison of rail and road costs was, outward, a consignment of 4 tons, and on the return journey returned empties by rail and an unloaded lorry by road.

[4] For Class 6 the standard terminals in 1938 were 1*s*. 9*d*. and the conveyance rates tapering rates as set out on an earlier page. Thus terminals contributed as a percentage of total charges—43 per cent for a 10-mile, 12 per cent for a 100-mile, 8 per cent for a 200-mile journey.

[5] *Report* of Rates Advisory Committee (1920), Cmd. 1098; Railways Act, 1921, 11 & 12 Geo. V, Ch. 55, Sec. 48.

of very short-distance traffic. With road traffic the terminal costs are limited to loading and unloading, for the motor lorry carries from door to door and the conveyance costs constitute a larger proportion of the total costs of transport. The small unit load of the motor lorry, as compared with the goods train, however, makes these conveyance costs on the road per ton-mile higher than on the railway. It is for these reasons that the road has the advantage over the

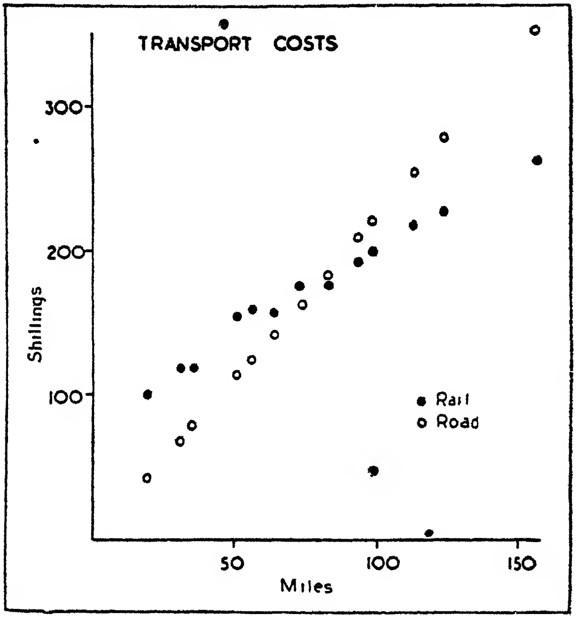

Fig. 84

COST OF GOODS TRANSPORT BY ROAD AND RAIL

Diagram drawn from data in C. T. Brunner, *The Problem of Motor Transport* (1928). Road and rail costs are plotted for specific distances, the road costs in hollow circles and the rail costs in dots. The costs are calculated for an outwards journey laden and a return journey empty, in the case of both road and rail.

shorter, the railway over the longer, distances. In evidence before the Barlow Commission, Sir Ralph Wedgewood admitted as a railwayman that 'the shorter distance traffic is very largely, in so far as it has gone, traffic that we cannot compete for. The traffic we can put up a fight for is the long-distance traffic.'[1] Nevertheless, there was by that date (1938) keen competition between road and rail for traffic travelling over distances of over 100 miles. There has been great improvement in the load capacity of a goods lorry of given

[1] Barlow Commission, *Minutes of Evidence*, Q. 5585.

unladen weight, and this increase in the efficiency of the vehicle increases the range of its competition.

This distinction according to distance, however, presents us with only an outline pattern of road goods traffic. The pattern is complicated further by (*a*) the greater relative development of road goods services between the major than between the minor centres of population, and by (*b*) the greater development of road traffic in some commodities than in others.

Road goods hauliers have developed services over distances of 50 miles and over between the large towns to a much greater extent than between the small, owing to greater likelihood of obtaining return loads.[1] Unless a road operator was assured of a return load, he quoted a rate for a single loaded journey sufficient to cover the cost of running his lorry in both directions. Wherever these conditions operate, they limit the effects of road goods transport in dispersing industry into rural areas and, in respect of regional distribution as distinct from local siting, they encourage equally with the railways the persistence of large nucleations of factories in urban areas. In local siting they tend to encourage main road sites peripheral to the town rather than in the centre of the town where there is traffic congestion. Much of this limitation of road goods services is doubtless due to the existence in the past of innumerable small road goods operators with limited clearing house information. It is also aggravated by the limitation of the number of road vehicles by the licensing system set up by the Act of 1933,[2] for road operators could not with any hope of success make application to pioneer new routes whose traffic was undeveloped and had become virtually limited to those routes whose traffic was already developed and on which they could prove to the Traffic Commissioners a need for their services. The larger firms with established depots more readily collected return loads than the independent operator owning a single vehicle and dependent for a return load largely on chance or on the casual services of a private 'clearing house'. The neglect of the smaller towns and the concentration of goods services on the routes between

[1] Dr. G. Walker discusses instances of traffic carried by road in bulk to a rail-head and there given to the railway for local distribution. He discusses other instances of traders sending large consignments by road and small by rail. The railways have a statutory obligation to carry all commodities offered. (Walker, op. cit., p. 109.)

[2] There are three kinds of licence: A, of hauliers who carry entirely for hire; B, who carry their own goods as well as for hire; C, who carry only their own goods. The A licences are not restricted as to area, and they are rather more difficult to obtain than the B licences, which are usually so limited. The C licences have gradually become more numerous, and by June 1937 they were responsible for 71 per cent of all licensed vehicles, though it is probable that the vehicles of the C licence holders were smaller and less continuously in use than those of the holders of an A licence. The Road Haulage Executive is acquiring the long-distance traffic formerly operated under A and B licences, but there is a marked tendency for large firms to take out C licences and to conduct their own transport.

the larger towns is likely to diminish with improvements in organization which the Road Haulage Executive appears anxious to provide.[1]

The greater development of road traffic in some commodities than in others has long been recognized and frequently discussed. If the tonnage of the three main groups of commodities on the four main-line railway companies in 1937 be compared with the tonnage in 1913, the index number at the later date (1913=100) was 77 for general merchandise (classes 7–21), 82 for low-grade general merchandise (classes 1–6), and 82 for coal. These time-changes were affected by trade depression as well as by road competition, but the effect of trade depression was more severe in coal than in general merchandise, and the railways lost little traffic in coal to the road. Railway traffics are now in 1950 higher than in 1937, but increase has been much more marked in classes 1–6 than in classes 7–21. Coal traffic has not increased owing to the decline in coal production. It may be concluded that road competition had affected the more valuable classes of general merchandise more severely than any other class of traffic. Dr. G. Walker has collected standard and exceptional railway rates and road charges for a wide range of commodities, particularly over routes leading to and from Birmingham. The figures which present these rates and charges in graphical form are most illuminating.[2] Relative to the present discussion the main point which emerges, particularly in that figure giving road and rail rates on the London-Birmingham run, is that, for the same distance and the same kind of service, road charges vary scarcely at all with commodity, while railway rates increase with the value of the commodity. Railway rates are based on value of service, road rates on cost of service. The full analysis of this is fundamental in transport economics, and it has important effects on the kind of commodities carried. Its geographical bearing will appear shortly. For the commodities in the lower ranges of the General Railway Classification, standard rail rates are less than road rates, particularly in respect of station-to-station rates by which most bulky commodities are carried by rail: but for the commodities in the higher ranges, road rates are less than standard rail rates. On the London-Birmingham run station-to-station standard rates are below road rates for coal and for classes 1–7, but above road rates for classes 8–20. The point of division is very significant, for it is classes 1–6 which consist of minerals and low-grade merchandise and classes 7–21 which comprise the manufactured commodities and foodstuffs. This comparison of rates, however, refers to standard rates, and the railway

[1] The Road Haulage Executive handled 27 million tons in 1949, a tenth of goods traffic on the railways. Empty vehicle mileage was 19 per cent of total vehicle mileage: corresponding percentages on the railway were 27 per cent for wagon mileage and 14 per cent for freight train mileage.

[2] Walker, op. cit., Figs. 2, 3, and 4.

can and does offer exceptional rates well below them. Some exceptional rates, particularly in the middle ranges of the classification, reach down to the level of road charges. It is clear that over distances of 100 miles or so (along such a route as the London–Birmingham run with an intensively developed traffic) coal, minerals, and low-grade merchandise will move by rail, but that road and rail will compete for other merchandise, the road having the cost advantage except where the railway can offer particularly low exceptional rates. The specific point of indifference between road charges and standard rail rates will vary according to the route, being presumably lower down the classification along shorter routes and higher up the classification along longer routes. There are other factors, of course, besides that of cost, which will determine the choice of a trader requiring the transport of a particular commodity along a particular route, such as the kind of service rendered, the greater punctuality of door-to-door collection and delivery, the lesser risk of breakage by road, and the advertising value of a road vehicle.

This differentiation between road and rail as to commodities carried has caused the railway to complain that it is losing the cream of its traffic, that is, those commodities which pay the highest rates. The road hauliers express a doubt whether the carriage of heavy low-grade commodities in bulk is as unremunerative to the railway as the railwaymen seem to infer, for these are carried in bulk, require little handling, and absorb little clerical time. The argument is of economic rather than of geographical interest, but if the basis of rail rate charging were changed and a cost basis substituted for a value basis, this might have profound geographical results, for the lower-grade commodities would presumably have to pay more and the higher-grade commodities less than at present. This would mean that, on the one hand, industry would be tied closer to its raw materials, but, on the other hand, that it would be able to distribute its finished consumption goods over a still wider radius. It will be interesting to watch developments consequential on the nationalization of the railways and of long-distance road goods transport, to see if differences in rate structure between them persist, and, if changes in rate structure occur, what their effects will be on the location of industry.

Passenger traffic by road is greater over short than over long distances relative to passenger traffic by rail. During the twenties of this century, when road services were developing rapidly, the London Midland and Scottish Railway lost traffic over the shorter distances, but gained it over the longer. As a result of detailed analysis between pairs of stations on the company's system for the years 1923 and 1927, receipts from passengers (other than workmen's and season bookings) decreased by 27 per cent for distances up to 10 miles, by 23 per cent for 11–20 miles, and by 9 per cent for 21–50

miles, but increased 2 per cent for distances of over 50 miles.[1] It is rather more possible to handle statistically the distance of road passenger travel than the distance of road goods traffic, for the tramway and omnibus companies are required to make returns. The classes of road passengers for which there are no statistical returns are those travelling in private cars and in taxicabs. The recorded number of passenger journeys was 3,845 million on electric trams and 5,418 million on motor omnibuses and motor-coaches in 1933. The tramcar traffic, of course, is entirely short-distance. This is particularly so in small towns, but even in the large cities, where there are relatively long-distance journeys to outer suburbs and peripheral municipal housing estates, the *average* journey on the whole system is still very short. In Liverpool during the 'thirties the average fare paid was little more than a penny farthing per passenger journey when the average distance of a penny fare was 2·09 miles, making an average journey for 1934 of just over 2½ miles. The average journeys in other towns and cities in that year were: 1¼ miles in Glasgow, 2 miles in Manchester, 1¾ miles in Birmingham, 1½ miles in Leeds, 1¼ miles in Aberdeen, 1¾ miles in Hull, and 1 mile in Cardiff. The average journey thus lay between 1 and 2 miles, rarely falling below 1 mile and rising above 2 miles only where there is a large proportion of journeys between town and suburbia.

The average distance of each passenger journey varies greatly on motor vehicles, according to whether they are omnibuses on stage services or whether they are express omnibuses, motor-coaches on excursions, or motor-coaches on contract work. These differences are important, for they help us to sort out the short-distance traffic. The average fare per passenger in 1937 on stage omnibuses was 2·16*d*., but on ordinary express buses 33·34*d*., on motor-coaches on excursions 26·84*d*., and on motor-coaches on contract work 13·00*d*. The stage omnibuses handled short-distance traffic as the tramways, though it is possible from the statistics available to give an average distance per passenger journey only for the London Passenger Transport Board.[2] For comparison, the average receipt per passenger journey by rail in 1938 was 18·47*d*. for all passengers (except workmen's and season bookings), and according to a special analysis for 1938–9 the average distance per passenger journey by rail was 21·92 miles.[3] The express buses, the motor-coach excursions, and the

[1] C. E. R. Sherrington and W. V. Wood, *The Railway Industry of Great Britain*, Mem. Royal Economic Society, no. 11 (1929).

[2] The average distance per passenger journey in 1944 on the services under the jurisdiction of the London Passenger Transport Board were 5 miles by rail, 2¼ miles by bus, 2¼ miles by tram, and 2¼ miles by trolley bus. For a sample period in 1938 the distance had been 4¾ miles by rail, 1¾ miles by bus and by tram, 2 miles by trolley bus. The railways under the L.P.T.B. include tubes, which are used for short-distance traffic of the kind carried by bus and tram, and the rest is suburban traffic offering few journeys of over 12 miles.

[3] It was 7·21 miles for workmen's and 12·45 miles for season bookings. The

motor-coaches on contract, therefore, carry passengers over somewhat comparable distances to the railways. While the stage bus is competitive with the tram, these long-distance bus services are competitive with the railway. The number of passenger journeys in 1937 amounted to 18 million on ordinary express services, 19 million on motor-coaches on excursions, and 71 million on buses on contract, while the number on stage journeys was 6,556 million. The number of passenger journeys on public road vehicles over distances comparable with those on the railway was thus, in 1937, some 108 million. The railways in that year carried 1,259 million passenger journeys. To the 108 million passenger journeys by road in public vehicles must be added some allowance for passenger journeys in private cars. A committee which drew up a memorandum in 1932 estimated this for 1931 at 150 million for other than local journeys on an allowance of two persons per car, but an estimate of this kind may be very wide of the mark. It may be remarked in parenthesis that not the whole of this traffic is strictly competitive with the railway, for some of the road traffic in private cars and in motor-coaches on tour would not exist but for the facilities afforded by the road. It is clear that the number of passengers travelling substantial distances in public motor vehicles is comparatively small. Such vehicles, in fact, are slower than railway trains over the longer distances and, except when there is overcrowding on the railways, present less comfortable quarters for a prolonged journey. It is possible to travel from Liverpool to London and back in the course of a working day by rail, but not by road. The railway has gained rather than lost on its long-distance passenger traffic of 100 miles or more.

Organized road passenger transport is now widespread. There is a close network of tram and bus services, and even rural districts with a low density of passenger movement have bus services, infrequent though they may be. In the built-up areas buses are gradually superseding trams, largely because of their greater flexibility and greater speed, despite the greater carrying capacity of the urban tram and the quick acceleration of some of the latest models. Because of the expense of laying track and cables, trams are quite unsuited to rural conditions and rural districts had no regular road passenger services until the advent of the motor vehicle. Outside the urban areas buses are almost invariably single-deck vehicles, and along other than through-routes they may run only a few days a week on a shuttle service to and from a village forming the equivalent of a rail-head. Many of the rural services were pioneered by men operating a single bus of small dimensions and, although most of these services have since been acquired by the larger companies,

equivalent mileages for 1945 were 39·32 (ordinary), 9·59 (workmen's), 12·34 (season). There was a conspicuous increase in long-distance travel, except in seasons.

some small proprietors still remain. In the Hebrides, in 1932, for example, there were nearly a hundred independent operators, each operating on a small scale and mostly acting as general carriers. Such general carriers in rural districts frequently undertake the carriage in the same vehicle not only of passengers, but also of all kinds of merchandise—meat, fish, and live stock. Services run by these small proprietors, even if primarily for passengers, frequently have a substantial parcels traffic as well. Such parcels on the main routes are carried by specialist carriers. In 1937–8 the percentage of all vehicles licensed by the Traffic Commissioners run by those operators who owned only a single vehicle was greatest in the northern Scotland, the Western and the Eastern areas, with 11 per cent, 7 per cent, and 6 per cent respectively. The percentage was least in the southern Scotland and North-western areas, with 2 per cent each. The contrast between rural and urban areas is clearly displayed.

V

COASTWISE SHIPPING SERVICES

Coasting services provide a fourth element in the internal transport system of Great Britain. Their relative importance was greater in the past than at the present. They carried much of the long-distance traffic in the pre-railway age, and they continued to do so after the railway came to possess a virtual monopoly of the long-distance inland traffic of the country. Coasting services to many small ports have decayed partly because of railway and, to a less extent, of road competition, and partly because of the disappearance of direct foreign trade at many small ports, owing to an increase in the size of ocean-going vessels. Because of the decline of their total trade, some of the small ports neglected to keep their equipment up to date and their channels clear. The development of small motor vessels around the coast and of motor lorries on shore, however, are instruments making possible the revival of coasting trade in the smaller ports. The quantities of shipping participating in the coasting trade are a little difficult to discover owing to the participation of (*a*) coasting vessels in the trade with the Low Countries, Western Germany, and Northern France (Brest to Elbe), as well as in the coasting trade proper, and (*b*) deep-sea vessels in the coasting trade, when sailing between British ports in the course of an inwards or outwards foreign voyage.[1] The tonnage of shipping to be attributed to the coasting

[1] The classification of individual vessels on a particular voyage between the foreign and coasting trades is by no means easy. The rule followed by the Board of Trade is as follows. So long as any cargo or passengers are carried which have come from or are destined to foreign countries, the vessel is recorded as engaged in foreign trade. But a vessel which sets down the *whole* of its foreign cargo at one British port and which takes up no more foreign cargo until leaving Britain direct for abroad is recorded in its voyages between British ports as engaged in

trade is set out in Table CI, according to the detailed inquiries conducted by the Chamber of Shipping of the United Kingdom. In 1936 it lay between 528 and 788 thousand gross tons, as compared with 13,728 thousand gross tons engaged wholly in the foreign trade, that is, approximately twenty times as much. These figures referred to registered tonnage. Each of these ships makes several voyages in the course of a year and, because of the shorter voyage involved, each coasting vessel arrives and departs many more times from British ports during a single year than a vessel wholly on foreign trade. The coasting tonnage, therefore, can carry relative to gross tonnage much more cargo than deep-sea vessels on long-distance voyages. The actual quantity of shipping arriving and departing coastwise with cargo and in ballast in 1938, was over 107 million net tons, as compared with a corresponding total for the foreign trade of 236 million net tons,[1] or, for shipping with cargo alone, 43 and 153 million net tons respectively (see Table CII). The coastwise total, however, includes many vessels engaged in the foreign trade but recorded as part of the coasting trade in their voyage from one British port, where they have set down their entire cargo, to another British port to pick up a new cargo for abroad. The actual tonnage by weight of goods carried in the coastwise and foreign trades for 1935 was 33 million tons coastwise and 116 million tons foreign.[2]

The organization of these coasting services presents a mirror of the organization of deep-sea shipping services.[3] There are coastal tramps as deep-sea tramps, coastal liners as deep-sea liners, coastal tankers as deep-sea tankers. The differences between liners and tramps in deep-sea shipping will be examined later in this chapter, but it is necessary to state here that liners, whether they carry passengers or not, are vessels sailing at regular times advertised beforehand and carrying a large variety of consignments, while tramps are vessels which sail to no prearranged time-table, and which are usually chartered to carry a single consignment, such as coal or grain. It will be noticed that the passenger liners, such as the Irish

the coasting trade. The coasting and 'home' trade includes vessels trading with Ireland, that with Northern Ireland being the coasting trade and that with Eire the 'home' trade. I have to thank Dr. L. Isserlis and Mr. H. Leak for their kindness in resolving some problems for me in respect of shipping statistics.

[1] This is of shipping arriving and departing, the aggregate of arrivals and departures at individual ports, not shipping entering and clearing the United Kingdom as a whole. A vessel *enters* the United Kingdom once on a foreign voyage inwards, but it may *arrive* at several individual ports in turn on that same foreign voyage inwards.

[2] Memorandum from the Chamber of Shipping of the United Kingdom to the Transport Advisory Council (*Report on Service and Rates* (1937), p. 33) and *Annual Report for 1935* of the Liverpool Steam Ship Owners' Association.

[3] The ownership of coasting vessels is not exactly parallel with that of deep-sea vessels, for the latter are owned mostly by companies independent of other businesses, while the former are owned also by public utility corporations such as gas companies, and by small proprietors acting as owner-skippers as well as by companies, and were owned by the railway companies prior to nationalization.

TABLE CI

Registered Shipping in Coasting Trade, 1936

	Tramp	Cargo liner	Passenger liner	Mixed cargo and passenger liner	Tanker	Total
Coasting trade only:						
Gross tons (thous.)	252	94	56	89	37	528
Net tons (thous.)	132	42	24	40	21	260
Deadweight tons (thous.)	352	115	13	57	42	578
Average net tonnage per vessel	324	381	529	440	705	379
Average deadweight tonnage per vessel	864	1,036	281	621	1,384	844
Partly in coasting and partly in home trade:						
Gross tons (thous.)	245	7	—	1	6	260
Net tons (thous.)	122	3	—	1	3	129
Deadweight tons (thous.)	332	9	—	1	8	350
Average net tonnage per vessel	391	268	—	679	430	388
Average deadweight tonnage per vessel	1,064	720	—	1,324	1,088	1,052

From L. Isserlis, 'Tramp Shipping, Cargoes and Freights', *Journal Royal Statistical Society*, vol. CI (1938).

Notes (1) The categories of vessels are defined later on pages 632–5.
(2) Registered net tonnage and gross tonnage both refer to the cubic capacity of the vessel in tons of 100 cubic feet. Gross tonnage is the total space within the shell of the vessel, net tonnage the gross tonnage less space taken up by crews' quarters, machinery, etc. Net tonnage is, thus an index of the space available for carrying cargo and passengers.
(3) Deadweight tonnage 'as understood by the shipowner and shipbuilder, usually means the maximum weight of cargo, stores, and fuel that the vessel can safely load under the most favourable conditions' (Isserlis, op cit., p. 62).

TABLE CII

Shipping Arriving and Departing Coastwise, 1938
(excluding Irish trade)

	With cargo			In ballast		
	No. of vessels (thous.)	Net tonnage (thous.)	Net tonnage per vessel	No. of vessels (thous.)	Net tonnage (thous.)	Net tonnage per vessel
Arrivals	87	21,629	248	91	32,307	356
Departures	86	21,760	253	92	31,730	344

From *Annual Statement of the Navigation and Shipping of the United Kingdom* for 1938 The returns for 1947 of vessels with cargo alone were arrivals 20,231 thous. net tons and departures 20,234 thous net tons.

boats on the Liverpool–Dublin run, are larger than the tramps in gross and net tonnage, but less in deadweight tonnage. They are not built to carry much cargo. Cargo liners are similar in these respects to tramps: the vessels are structurally similar, or even identical, but they differ in the organization of their services, the one following a prearranged time-table and the other sailing only when required. The overlap between the coasting trade and the short sea voyages to the adjacent parts of the Continent is chiefly in tramps, the liners keeping either to the one or the other.

The geographical pattern of this coasting trade in 1938 is displayed in Fig. 85. The first point that stands out is that the major ports of the country do not dominate the coasting trade to the same degree as they dominate the deep-sea trade.[1] The coastwise trade is a business of the small ports as well as of the large, despite the distribution coastwise of imported commodities from the large general ports, and despite the function of the large ports as the terminus of much coastwise traffic. From the later Middle Ages onwards the small ports have served this function; they have provided much of the local or branch-line shipping traffic while the large ports have been the channels of the main-line shipping traffic of the ocean lanes of the world. The second point is that in the coasting trade arrivals with cargo are more evenly distributed around the coasts than departures with cargo. Departures with cargo are mainly of two kinds: first, the coastwise distribution of imported produce from the large ports, and, second, the coastwise distribution of bulk cargoes, such as coal from the coalfield ports and slates from the North Wales ports. Such departures are localized to certain areas. Arrivals with cargo are much more widely spread, for they represent the dispersal among a number of small ports of the coastwise distributive trade of the large ports and of the coalfields. The third point, which follows from the above, is that the coalfield ports display a very unbalanced coastwise trade, consisting of large quantities of tonnage departing with cargo, but very small quantities arriving with cargo. Their foreign trade was in 1938 unbalanced in precisely the same way, though not quite to the same degree. Thus the Tyne ports had in 1938 twice the tonnage departing with cargo as arriving with cargo in the foreign trade, but five times as much in the coasting trade. The balance is made up by a movement of vessels in ballast. The foreign and coastwise trades are by no means each separate and self-contained. Some coastwise arrivals in ballast depart with cargo to a foreign destination. This is shown in its simplest form at Blyth, but it is present also on the Tyne and at Cardiff, which are general ports as well as coal ports, and which do a large bunkering business. Of the

[1] While the six ports of London, Liverpool, Bristol, Hull, Glasgow, and Southampton, had in 1938 59 per cent of the arrivals with cargo and 46 per cent of the departures with cargo in the foreign trade, they had 47 per cent of the arrivals with cargo and 22 per cent of the departures with cargo in the coastwise trade.

COASTWISE TRADE OF GREAT BRITAIN BY PORTS IN 1938

A, *Arrivals with Cargo.*

B, *Departures with Cargo*

Map drawn from tables in *Annual Statement of the Navigation and Shipping of the United Kingdom* It will be noticed that the scale of the symbols is not identical with that of Fig. 86

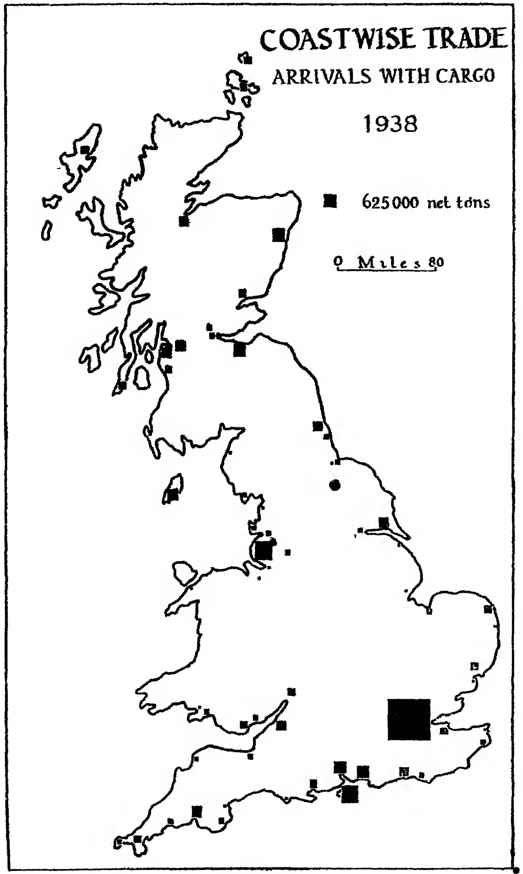

Fig. 85A

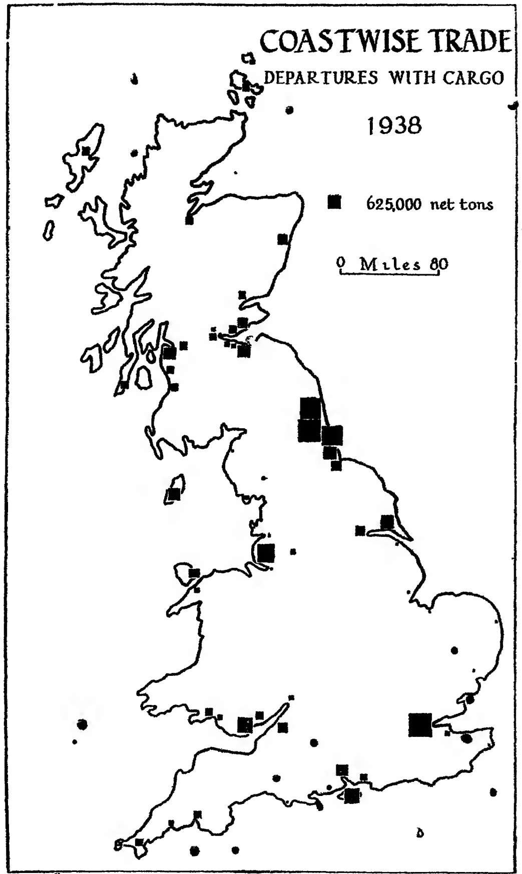

Fig. 85B

vessels which arrive coastwise in ballast and depart with cargo in the foreign trade, most are tramps, and it will be recalled that the overlap between the coasting and near-continental trades is chiefly in tramp shipping. To give a concrete example, some are deep-sea tramps bringing a cargo of foreign grain to London, discharging the whole of the cargo at London, leaving London in ballast coastwise to the Tyne, and loading on the Tyne with a cargo of coal for a foreign destination. Voyages of this kind are common. The fourth point is the special case of London. Its coastwise trade comprises two elements: first, the coastwise export of imported commodities, and, second, the coastwise import of coal from the North-east Coast. Departures with cargo coastwise are in about the same proportion to arrivals with cargo in the foreign trade in the Port of London as in the other major ports of the country. The coastwise distribution of imported commodities is thus common to all the major ports. The huge import of coal coastwise, however, is a peculiarity of London. It is no new thing, for it was developing in Tudor times. Apart from the small Kent coalfield, London is distant from coal supplies and coal, a heavy low-grade commodity which cannot bear high transport charges, is subject to a long train haul. Coal comes into London by rail from the Midlands and from Nottinghamshire and Derbyshire, and coastwise by sea from the North-east Coast,[1] a traffic encouraged by the coastal position of both coalfield and point of consumption and by the lower rates of carriage by sea than by land. Coastwise traffic in coal is mostly a business of specialist colliers with a high ratio of hold-space to gross tonnage, and some of these vessels are owned by bulk consumers of coal, such as the gas companies. The other large coal-consuming centres of Britain are on or near the coalfields and long-haul coal transport by rail does not arise to the same extent. Nevertheless, there is a good deal of coastal shipment, from West Cumberland, West of Scotland, Firth of Forth, South Wales, and from isolated coastal pits like that of the Point of Ayr in North Wales.

The commodities involved in this coastal traffic comprise mainly those available in bulk quantities—coal, grain, oil-cake, stone and slate, slag and fertilizers. Grain is shipped coastwise from importing ports to flour-mills in the same way that it is carried by canal barges to inland flour-mills. Oil-cake and stock foods are transported to small ports in stock districts for local distribution to the farms by road, as, for example, from Liverpool to the small ports in West Cornwall. Slates are brought by small coasters from little ports along the North Wales coast, communicating by light railway with mountain quarries, to Merseyside and elsewhere. Stone is carried coastwise from coastal quarries, such as that of Penmaenmawr, in North

[1] For relative proportions, see Figs. 44 and 45 in Ll. Rodwell Jones, *The Geography of London River* (1931).

coastal vessel approximately 8,250 million. It is not possible to give an estimate of ton-mileage for road traffic.

Coastwise shipment, therefore, competes with both road and rail. Competition with the canal is negligible and competition with the road is chiefly in the distributive trade of the large importing ports. Coasting services have the advantage of bulk handling under circumstances specified in the preceding paragraph. Within the confines of a port lighters can compete very successfully with the road when cargoes can be handled overside. There is a great deal of such lighter traffic on the Thames and there is some on the Mersey. Competition with the railway is over a wider field and for the longer distance traffic. The canal and the road are primarily short-distance carriers: the coasting services and the railway between them handle by far the greater part of the long-distance traffic. Coastal shipment has the advantage for port-to-port traffic, the railway for inland traffic. Competition between them is chiefly in respect of those long-distance routes which involve for rail a through journey, but for coastwise shipment a short rail haul at either terminal point, as well as a long journey by sea in between. Coastwise shipping interests complain that the railway manipulates its rates in order to decrease its charges on the long rail haul so as to attract traffic to the railway for the complete journey, and to increase its charges on the short rail haul to and from the ports so as to repel traffic from coastwise shipment. Coastwise shipping interests also complain that railway-owned ports specifically discourage coastwise shipment, if that is in competition with rail haulage, and that both exceptional rates and Agreed Charges have acted in a way detrimental to coastwise traffic. Like road haulage rates and unlike the value rates of the railways, shipping freight rates are cost rates and may vary considerably within the space of a single year.

Coastwise services have not been without their influence on the location of industry and of population, both in respect of regional distribution and of local site. Their effect has been part and parcel of the effect of shipping services generally. Effects on regional distribution of industry arise in two ways. The first is the establishment of industries based on imported commodities. Some industries using imported materials, like the textile, handle materials relatively light and valuable in proportion to their weight, and they have remained in inland districts where they were originally established for other reasons. Other industries, however, using bulkier and less valuable materials, such as grain-milling or sole-leather tanning or the re-rolling of imported steel bars, have come to be congregated in and around the major importing ports. Examples of these have been examined above in reference to specific industries. As a result, the ports have become industrial centres of some magnitude and their economic structure to-day is very different from their economic

structure a century previous. This has affected chiefly those ports receiving imports of bulk commodities direct from abroad, but ports receiving their bulk commodities coastwise have also been involved. The second effect of shipping services is bound up with the coastwise shipment of coal. This has enabled ports to obtain coal for industrial consumption, at any rate, much more cheaply than would otherwise have been the case, and has, therefore, facilitated the growth of both industry and population in the ports. London particularly has been a beneficiary of this coastwise shipment, for London's riverside factories depend almost entirely on coastwise transport, though domestic coal is largely carried by rail. The effects of shipping services on the local siting of factories are most marked in those factories handling bulky low-grade materials, for such factories have developed along the water-front where deep-sea and coasting vessels or lighters could be loaded or unloaded directly from or into the factory itself. In the Port of London such loading and unloading overside into and from lighters is highly developed, owing partly to the Free Water Clause which permits lighters to enter docks free of toll, and an official of the Port of London Authority reported that 7 million tons of cargo were handled in this way.[1] A huge quantity of cargoes, both foreign and coastwise, passes upstream to be unloaded at factory wharves or passes downstream from these factory wharves to sea-going vessels in dock or in mid-stream. Some small coasters can themselves berth at factory wharves without the aid of the lighter. The advantage of access to the water channels of the port leads, of course, to a linear location of factories, gas plants, and power stations along the water-front.[2] Shipping services have had effects on the local distribution of population, in so far as dock labour and seamen tend to live near their place of employment. There is a somewhat similar tendency of railwaymen to live near a railway station, but in the case of dock labour this was heightened by the stand system, whereby unemployed dock labour was kept as an available reserve ready for use immediately a ship berthed. There have been changes in the organization of dock labour over many decades, culminating in a radical change during the late war. It may prove to be possible for dock labour to have a greater freedom in choice of residence in the future.

[1] Barlow Commission, *Minutes of Evidence*, Q. 4665–71. Professor Rodwell Jones estimated that nearly 80 per cent of the tonnage of commodities imported are delivered outside into lighters either in the docks or in the river (op. cit., p. 145). This is more than the 7 million tons reported by the Port of London Authority for the docks.

[2] Rodwell Jones, op. cit., Chapter XI The more extensive use of lighters in London than on Merseyside, coupled with the very different lay-out of dock estates at the two ports, has led to a much greater development of water-front industry on the Thames than on the Mersey.

VI

DEEP SEA SHIPPING SERVICES

The discussion of transport has so far been concerned with internal traffic within the confines of Great Britain. Overseas shipping is as fundamental to the economy of Britain as railways, roads, canals, and coastwise shipping, for, while internal transport permits regional specialization of production within the country, shipping services permit Britain to occupy a specialist place in the economy of the world. Britain's specialization as a manufacturing and trading country would have been impossible without the facilities which shipping affords of importing foods and raw materials and of exporting finished manufactures. The approach to a geographical analysis of overseas shipping traffic is necessarily rather different from the approach to an analysis of internal traffic. The pattern of traffic is much more fluid. The sea is a broad highway and the route is not dictated in detail by topography. It is true that there are shipping lanes determined by the lie of the land-masses and ocean basins and by the shortest distance between points on a globe, but these dictate only the general direction of the route and not its detailed and precise course. Further, shipping services are not concerned with problems of constructing and maintaining their track; they pay tolls for the use of terminal facilities in the form of docks and harbours, but they pay no toll for the use of the sea highway. This has its implications in the structure of freight rates. Ship-owners' capital is invested not in a track, but in a vehicle, which is not tied down to any one route, but is free to move where its services are required. Ocean transport is very much cheaper than land transport over a given distance, partly because of the great bulk of the unit load, and partly because of the smaller amount of power required to propel through water than to haul on a land surface. It costs less to carry iron ore to Teesside from Algiers than from Northampton. While the carriage of coal by rail in Great Britain, before the late war, was 1*d.* per ton-mile, it was, by sea, little more than one-tenth of a penny per ton-mile from the Tyne to Copenhagen and one-fortieth of a penny per ton-mile to Alexandria.

In order to clarify the analysis of shipping traffic it is necessary to consider briefly the general organization of shipping services and to trace the effect on them of geographical conditions. Shipping plying for hire or reward is classified as either liner or tramp. In addition, there are specialist vessels, such as tankers, whalers, cable-layers, etc., undertaking specialist functions, which stand outside this classification. The distinction between liners and tramps is fundamental in the organization of shipping traffic. It is, in part, a difference in the structure, size, and speed, of the vessel. Tramps have a deadweight tonnage greatly in excess of net tonnage, while

passenger liners have a deadweight tonnage less than net tonnage.[1] But *cargo* liners have a very similar ratio between net and deadweight tonnage as tramps. Tramps are slower and smaller vessels than passenger liners, but there is little difference in speed or size between tramps and cargo liners. The same type of vessel can thus equally be a tramp or a cargo liner, except that tramps liable to call at small ports with little shore equipment have usually more deck equipment for handling cargo. Mixed cargo-passenger liners have structural characteristics intermediate between those of the purely passenger and purely cargo liners. There are not, therefore, differences in structure, size, or speed, that would make possible a watertight classification into liners and tramps. There is a second difference between them. Liners are almost invariably owned in fleets, for otherwise regular services could scarcely be guaranteed, while tramps are sometimes owned by single operators who have no other vessel. But there are tramp fleets equally with liner fleets, and this would prove an even more unsatisfactory test. There is a third difference. Tramps usually carry bulk cargoes filling their entire hold-space, and consist frequently of low-grade commodities in a single consignment; while liners of all kinds usually carry general merchandise in a large number of separate consignments frequently filling only a part of the total hold-space. Tramps carry the less valuable, liners the more valuable, commodities. But this again does not give a watertight classification, for, although tramps rarely carry the more valuable goods, liners do on occasion carry cargoes of low-grade commodities made up into bulk consignments. In the latter part of the nineteenth century grain shipments from the United States to Britain were carried by liners, which looked upon them as ballast, and which were prepared to carry them for such low rates that tramps could scarcely compete. The true distinction between liners and tramps is none of these. A vessel is a liner when it runs to a regular time-table. A vessel is a tramp when it runs to no regular time-table and when it is hired on charter-party terms. The same vessel may thus during the course of its history run at one time as a tramp and at another as a liner. It may even alternate frequently. As a matter of regular practice some ships leave Britain as liners and return as tramps in the course of a single round voyage. Such a practice fits in neatly with the different character of the outward and homeward trades, as will appear later. It is an adjustment to the traffic conditions, and ultimately to the geographical conditions, of the route.

Tramps and liners each have their own special function in shipping services. Tramps pioneered many ocean trade routes during the

[1] In 1936 British deep-sea tramps had an average net tonnage of 2,669 and an average deadweight tonnage of 7,514, while British deep-sea passenger liners had tonnages of 9,944 and 8,801 respectively. Deductions from gross tonnage in order to arrive at net tonnage are also less on tramps than on passenger liners, but cargo liners are similar to tramps in this respect too.

nineteenth century, when traffic was insufficiently developed to justify liner services, but with the regularization and increase of trade much of it has subsequently been acquired by liners. Tramps specialize in seasonal cargoes, such as grain or rice or soft timber, which are available only at particular seasons after harvest, or, in the case of timber from the coniferous belt of the Northern Hemisphere, only when the sea approaches are ice-free. Liner services operating throughout the year could handle only a part of such seasonal cargoes and the liners themselves would have little remunerative cargo for the rest of the year. By reason of their very nature, tramps can congregate at the ports of shipment precisely and only when seasonal cargoes are available. Tramps can thus afford to carry seasonal cargoes for lower freight rates than can liners, which would have to charge more on seasonal cargoes in order to make up for losses on unremunerative voyages during the rest of the year. Liners specialize in commodities shipped in even quantities throughout the year. The regularity of service, of collection, and of delivery, and the greater care in handling which liners provide, is of more value to traders in some commodities than the lower costs of carriage by tramps, whose cheapness is offset by irregularity of service and roughness of handling. Tramps specialize in the carriage of bulky low-grade commodities, which can be carried considerable distances by sea only if they can be carried very cheaply. While grain occasionally may be a liner cargo, coal never is. The freight rate per ton in 1935 on coal from Cardiff or Newport to the River Plate was 8*s.* 10$\frac{3}{4}$*d.*, but on grain from Buenos Ayres or La Plata to the United Kingdom, 14*s.* 7$\frac{3}{4}$*d.* Liners, of course, carry all the mails and almost all the passengers. Mails make a large contribution to total liner receipts. Passenger and cargo-passenger liners provide the comfort and amenities, the speed and the regular arrival and departure according to schedule which passengers expect.

The proportion of British shipping sailing as tramps and as liners can be estimated in only general terms. In its *Annual Report for 1933* the Liverpool Steam Ship Owners' Association estimated that liner tonnage constituted 60 per cent, tramp tonnage 30 per cent, and tanker tonnage 10 per cent of the total. In 1913 tramp tonnage had been greater and liner tonnage less, both actually and relatively: it was usually estimated before the 1914–18 war that tramps constituted 60 per cent of total British tonnage. There is a more detailed estimate for 1936, made by Dr. Isserlis, then of the United Kingdom Chamber of Shipping. Particulars are set out in Table CIII. The decline in British tramp shipping is due partly to the encroachment of liners as trade has become more stabilized, partly to the decline in shipment of coal (essentially a tramp cargo), partly to the increase in tankers consequential on the use of oil, and partly to the increase in foreign tramp tonnage, some of it of old ships acquired and manned

very cheaply. Not the whole of British-owned tramp and liner tonnage is engaged in traffic to and from Great Britain, some being in the foreign-foreign trade, empire-empire trade, and empire-foreign trade. A sample collected for 1931 gave 24·5 per cent, and another sample for 1936 gave 28·3 per cent of the net receipts of British shipping earnings (excluding the coasting trade) as derived from traffic other than that to and from Great Britain.

TABLE CIII

Proportion of Liners, Tramps, and Tankers in British Shipping, 1936 and 1947

	Tramps	Cargo liners	Passenger liners	Passenger cargo liners	Tankers	Total
All shipping, 1936:						
Net tonnage	29	32	5	20	14	100
Deadweight tonnage	36	33	2	13	16	100
All shipping, 1947:						
Gross tonnage	35	27	5	12	21	100
Deadweight tonnage	40	28	2	7	23	100
Excluding Coasting Shipping, 1936						
Net tonnage	28	33	5	21	13	100
Deadweight tonnage	35	35	2	13	15	100

Returns for 1936 from L. Isserlis, 'Tramp Shipping Cargoes and Freights', *Journal Royal Statistical Society*, vol. ci. (1938). Returns for 1947 from *Annual Report 1947–1948*, Chamber of Shipping of the United Kingdom. It was pointed out that many vessels classed as tramps have, in fact, been acquired by liner companies. The apparent percentage increase in tramp and decline in cargo liners may thus not be real.

The quantities of shipping engaged related to the cargoes involved in the foreign trade[1] of Great Britain are set out in Table CIV. The weights of imports and exports are not recorded for all commodities in the *Annual Statement of Trade of the United Kingdom*, and the weights of cargoes entered in the table are therefore estimates. From the point of view of filling shipping space, weights are more significant than values. The numerical relationship between cargoes and shipping space is between unlike quantities, as explained at the foot of the table. But, although the quantities (apart from shipping tonnages) possess no exactitude and must be regarded with many qualifications, they are extremely valuable in interpreting the shipping traffic of Great Britain. Quantities are given for 1913, 1929, and 1937, which

[1] This ought more accurately to be described as overseas trade, for it involves trade with the Empire as well as with foreign countries, but it is described as foreign trade in statistical returns, except in those of the Liverpool Steam Ship Owners' Association.

represent the crests of trade-cycle fluctuations, for 1932, which represents the trough of the Great Depression, for 1938 and 1946, which represent the years immediately preceding and succeeding the war, and for 1950.

TABLE CIV

Shipping and Cargoes in British Overseas Trade, 1913–50

	1913	1929	1932	1937	1938	1946	1950
CARGOES, in million tons weight							
Imports:							
Food, drink, and tobacco	18·7	19·0	20 7	22·0	22·0	10·6	14·5
Raw materials . .	28·9	27·0	19·1	35·6	28·6	21·0	35·0
Refined petroleum .	1·8	6·1	6·8	9·1	9·4	11·7	9·4
Manufactures . .	6·6	8·4	5·7	8·6	7·3	3·7	4·3
Total . . .	56·0	60·5	52·3	75 3	67·3	47 0	63·2
Exports:							
Coal	76·7	64·4	41·9	43·5	38·2	5 0	16·2
Other than coal . .	16 9	17·0	10·1	13·5	11·5	10·9	15·5
Total . . .	93·6	81·4	52·0	57·0	49 7	15·9	31·7
SHIPPING, in million net tons							
Entrances with cargo:							
Total . . .	49·1	62·7	59·4	70·4	68·4	33·9	57·4
Cargo carried per 100 tons of shipping .	114	96	88	107	98	138	110
Clearance with cargo:							
Colliers . .	34·9	29·3	19 0	19 8	17·4	2 2	7·3
Other than colliers	33·0	39 4	36 4	41·6	41·5	18·9	37·9
Total . .	67·8	68 7	55·4	61·4	58·9	21·1	45·3
Cargo carried per 100 net tons of shipping:							
Colliers . . .	220	220	220	220	220	220	220
Other than colliers .	51	43	28	32	28	58	34

From *Annual Reports* of the Liverpool Steam Ship Owners' Association.

Notes (1) The tonnage clearing with coal is estimated on the assumption that colliers clear only fully laden and that they carry 220 tons weight per 100 net tons of shipping space. In stowage, coal ranges between 42 and 52 cubic feet per ton of 2,240 lb., i.e. 192 to 238 tons weight per 100 net tons shipping space.

(2) The cargo carried in tons weight per 100 net tons of shipping space is a rough way of establishing a numerical relationship between cargoes and shipping space. It is rough only for the stowage space of cargoes varies enormously. The cubic feet of shipping space required for a ton weight of cargo is 45 for wheat in bulk, 50 to 53 for wheat in bags, 90 for apples in cases, 18 to 25 for iron ore, 100 to 150 for bales of raw cotton, 12 to 15 for pig iron, to give some examples. It is, moreover, a comparison of two unlike quantities, space and weight.

Though fluctuating between crest and trough, import cargoes increased at trade-cycle crests, but they are less under the controlled economy of to-day. There was before the war a steady increase in the import of foodstuffs as the population of Great Britain grew and as grass dairying increased at the expense of arable farming and

meat production, but these trends were reversed in 1939. There has been a rapid growth of the imports of refined petroleum, but this is now being replaced by imports of crude petroleum with the increase in capacity of British refineries. Import of raw materials has fluctuated widely between boom and depression: it has been well maintained since the war. The growth of import cargoes was accompanied during the inter-war period by a growth of shipping entrances, which had, in fact, increased at a faster rate. Nevertheless, the employment of shipping on the homewards run was well maintained. Owing to shortage of shipping after the war, this is still true. This reflects the bulk cargoes on the homewards run, foodstuffs, petroleum and raw materials being responsible for no less than 89 per cent by weight of import cargoes in 1938, and 93 per cent in 1950. But, while the weight of import cargoes rose between the wars, the weight of export cargoes fell. The weight of coal exports in 1938 was only one-half, and of manufactures only two-thirds, of what they had been in 1913. After the war, coal exports were well below even the 1938 level, but export of British manufactures has risen to equal the 1929 level. There was during the inter-war years more shipping available for export cargoes, but fewer cargoes to be carried. Many ships cleared in ballast, and those which did clear with cargo left with their holds only partly full. Even in 1913—a year of active export trade—the quantity of cargoes by weight for 100 net tons of shipping space was probably insufficient to fill liners' holds. The colliers, of course, departed with full holds. Since 1932, exports by weight have been less than imports by weight. In the immediate future it is unlikely that coal exports will reach even the level of the 'thirties. The employment of tramps on the outwards run will be correspondingly diminished and, if tramps bring in foods and raw materials to Britain, many will have to leave in ballast and pick up outwards cargoes elsewhere. It is likely indeed that the proportion of liners will increase still further.

This is the outline of shipping traffic to and from British ports. It can be filled in in respect of composition of cargoes and in respect of its geographical distribution over the world. The most informative analysis in respect of cargoes, though it refers only to tramp cargoes, is that by Dr. Isserlis, in his paper 'Tramp Shipping, Cargoes and Freights'.[1] This investigation was made possible by the records collected as a result of applications for assistance to the Tramp Shipping Subsidy Committee appointed by the Act of 1935.[2] Particulars of some 12,491 voyages were analysed, but of these some 2,909 were voyages which did not involve any British port, and these have accordingly been discarded (see Table CV). The smaller tramps of under 3,000 tons gross were engaged mainly in the home or near-continental trade. The actual quantities of cargoes carried

[1] *Journal Royal Statistical Society*, vol. CI (1938).
[2] British Shipping (Assistance) Act, 1935, 25 Geo. 5, Ch. 7.

TABLE CV

Tramp Voyages of British Shipping, 1935

Vessels with Cargo

	Outwards			Inwards			Outwards	
	UE	UF	Total	EU	FU	Total	UF Coal	UF Not coal
Number of vessels:								
3,000 tons gross and over	322	911	1,233	460	809	1,269	890	21
Under 3,000 tons gross	31	4,442	4,473	4	2,076	2,080	4,079	363
Total	353	5,353	5,706	464	2,885	3,349	4,969	384
Cargo in thou. tons weight:								
3,000 tons gross and over	2,046	5,904	7,950	3,548	5,430	8,978	5,789	115
Under 3,000 tons gross	98	7,621	7,719	6	2,985	2,991	7,292	329
Total	2,144	13,525	15,669	3,554	8,415	11,969	13,081	444
Average freight in £ per ton:								
3,000 tons gross and over	0·38	0·41	—	0·90	0·69	—	0·40	0·59
Under 3,000 tons gross	0·34	0·24	—	1·50	0·36	—	0·24	0·23

UE = From the United Kingdom to Empire countries.
EU = From Empire countries to the United Kingdom.
UF = From the United Kingdom to foreign countries.
FU = From foreign countries to the United Kingdom.

From L. Isserlis, 'Tramp Shipping Cargoes and Freights', *Journal Royal Statistical Society*, vol. CI. (1938)

by this sample of voyages were 15·7 million tons outwards and 12·0 million tons inwards.[1] Of the export cargoes, 14·9 million tons were of coal, of which almost half was carried by the smaller tramps. Practically the whole of the export of coal to France was carried by the smaller vessels. Of the larger tramps sailing for the more distant destinations, most, if not all, appear to have returned with cargo, but of the smaller tramps in the near-continental trade, about half appear to have returned in ballast or to have done some trading between foreign countries before coming back to Britain. Of the export cargoes, other than coal, carried by tramps, the smaller vessels shipped to the Continent pitch and asphalt, iron and steel and scrap, fertilizers, china clay, and some general cargo, while the larger vessels shipped, mainly to the Dominions and the United States, china clay, fertilizers, and a good deal of general cargo. On the inwards run, most of the grain was carried by the larger tramps from South America, Canada, Australia, South Africa, and South Russia. Timber, on the other hand, was chiefly a small tramp cargo from the Baltic and the coasts of France and Portugal, but a large tramp cargo from the White Sea and British Columbia. A considerable number of vessels from British Columbia carried both grain and timber on the same voyage. The ore imports were shared between large and small tramps, the small tramps handling all the Bilbao traffic and the large tramps most of the Mediterranean traffic. The small tramps returning to Britain with Bilbao iron ore had almost certainly left Britain with coal to a French port. This is a well-known example of the round voyage. Some of the smaller tramps taking coal to France returned alternatively with timber, usually pit-props, from West France or Portugal.

The geographical distribution of shipping to and from the United Kingdom is recorded for large traffic areas by the Board of Trade,[2] and for individual vessels, omitting those under 3,000 tons gross, on two particular sample days by the Admiralty.[3] I will examine the

[1] Those carrying coal outwards earned freight at the rate of 4*s*. 9½*d*. per ton, which is of the same order of magnitude as the known average coal freights in 1935 of 4*s*. 7½*d*., Cardiff to St. Malo; 4*s*. 5½*d*., Tyne to Boulogne. The larger tramps of 3,000 tons gross and over, carrying coal outwards, earned freight at the rate of 8*s*. per ton, which is of the same order of magnitude as the known average freight rate per ton in 1935 of 7*s*. 7¾*d*., Cardiff to Malta; 8*s*. 10¾*d*., Cardiff to River Plate; and 7*s*. 4½*d*., Tyne to Oran. Inwards cargoes earned higher freights per ton, for although still tramp cargoes, they consisted of more valuable commodities than coal and, moreover, they were usually carried over greater distances. Very little coal is exported beyond the Atlantic and the Mediterranean, but tramp cargoes come in from all parts of the world. The average freight earned per ton by the larger tramps on the inwards voyage was 18*s*. from Empire and 13*s*. 9½*d*. from foreign ports. The known average freight on grain per ton in 1935 was 14*s*. 7¾*d*. from the River Plate, 13*s*. 11½*d*. from South Africa, and 1*s*. 9½*d*. per quarter from Montreal. In all of these instances the freight actually earned and the known freight rates of the year on recognized routes are thus in tolerable agreement.

[2] Before the war in the *Annual Statement of Navigation and Shipping* and now in the *Board of Trade Journal* and the *Accounts . . . Trade and Navigation*.

[3] *Geographical Distribution of British Empire Shipping*, B.R. 84 for 7 March 1936 and B.R. 135 for 24 November 1937.

tables of the Board of Trade first. The distribution of shipping as between the several trading areas for the years 1938 and 1950 is set out in Table CVI. It will be noticed immediately that total entrances[1] from, and total clearances to, each trading area do not exactly balance. Some discrepancy is due, of course, to voyages in progress at the end of each year, but the discrepancies are usually much larger than could be explained on these grounds. If all shipping services were shuttle liner services moving backwards and forwards on precisely the same route they should balance, but the irregular movement of tramps greatly complicates the pattern, for a tramp may not, indeed frequently does not, re-enter a British port from the same trading area to which it had cleared some weeks or months previously. Tramps taking coal to the Eastern Mediterranean may have returned with oil-seeds from India or with grain from Australia. The discrepancies between total entrances and total clearances for individual trading areas do, in fact, fall into regional groups. Those whose entrances from exceeded clearances to, in 1938, comprised areas 1, 6, 7, 8, 12, and 13; that is (apart from Eire), the Indian Ocean and the Pacific. Those whose clearances to exceeded entrances from, comprised areas 2, 3, 4, 5, 9, 10, and 11; that is, Europe and the Atlantic. Most of the Atlantic ports are nearer to Britain than the ports of the Indian and Pacific Oceans. Some vessels thus clear for the nearer ports, but return from the more distant. This was in 1938 bound up with the export of coal, very little of which passes beyond Suez, Panama, or the South Atlantic. Some of these infinitely varying tramp voyages cancel each other out, but the residue is of tramps which clear to the nearer, but return from the more distant trading areas.

A second point is equally obvious. There are even greater discrepancies in entrances and clearances with cargo than in total entrances and clearances. Entrances with cargo exceed clearances with cargo, and this ties up with the excess of imports by weight over exports by weight since 1932, as shown in Table CIV. The warning must be expressed, however, that two vessels with cargo may be very unequally laden, and that similar totals of tonnage with cargo may not be at all comparable in weight of cargo carried. Returns of tonnage with cargo can be taken as no more than rough guides. But, with these qualifications in mind, it will be noticed that there is a regional pattern in the relationship of entrances with

[1] In attributing a particular voyage to a particular trading area, the rule followed by the Board of Trade is that 'vessels bringing cargo to the United Kingdom from more than one port abroad are recorded as arriving from the first port at which cargo for the United Kingdom was embarked on the current voyage', and that 'vessels embarking cargo in the United Kingdom for more than one port abroad are recorded as departing for the last port at which any of such cargo is to be disembarked on the current voyage'. As tramp voyages are between single ports they present few difficulties in classification: it is the liners calling at several ports *en route* that offer most difficulties. A liner departing for Australia, but calling *en route* at Port Said and at Columbo, is thus recorded in area 8 and not 4 or 6.

TABLE CVI

Geographical Distribution of Shipping Trading with the United Kingdom, 1938 and 1950

(in million net tons)

	1938 Entered from			1938 Cleared to			Total entrances compared with total clearances	1950 Entered from	1950 Cleared to
	With cargo	In ballast	Total	With cargo	In ballast	Total		With cargo	With cargo
1 Eire	3.82	1.77	5.59	4.51	0.83	5.35	+0.24	3.54	4.21
2 Northern Europe	18.79	13.00	31.79	18.01	14.04	32.05	−0.26	13.89	11.92
3 Atlantic Europe and West Mediterranean	8.59	6.67	15.27	9.62	5.89	15.51	−0.24	8.60	6.05
4 Central and East Mediterranean	2.27	0.68	2.95	2.44	1.15	3.59	−0.64	1.97	1.75
5 West and South Africa	1.72	0.23	1.95	1.78	0.62	2.40	−0.45	2.62	2.11
6 East Africa, Persian Gulf, and India	4.40	0.19	4.59	3.09	1.42	4.52	+0.07	6.43	2.87
7 Eastern Asia and Pacific Isles	2.58	0.04	2.62	1.64	0.25	1.89	+0.73	1.48	1.53
8 Australasia	3.27	0.02	3.29	1.83	0.37	2.20	+1.09	2.70	2.96
9 North America–Atlantic	13.88	0.74	14.62	11.04	3.95	14.99	−0.37	8.23	6.91
10 West Indies and Middle America–Atlantic	4.29	0.06	4.35	1.07	3.49	4.56	−0.21	3.81	0.59
11 South America–Atlantic	2.65	0.06	2.71	3.14	0.24	3.39	−0.68	1.69	1.81
12 South and Middle America–Pacific	0.48	0.02	0.50	0.27	0.07	0.34	+0.16	0.27	0.23
13 North America–Pacific	1.47	—	1.47	0.42	0.82	1.23	+0.24	0.74	0.54
14 Elsewhere	0.17	0.02	0.19	0.02	0.13	0.15	+0.04	0.17	0.01
Total	68.37	23.51	91.88	58.88	33.28	92.16	—	56.14	43.49

From *Annual Statement of the Navigation and Shipping of the United Kingdom* for 1938, and from *Board of Trade Journal*, vol. CLX, no. 2825 (1951). These returns for 1950 are revised and differ from those in Table CIV drawn from the *Accounts relating to Trade and Navigation* for December 1950 which were unrevised.

cargo to clearances with cargo, some areas showing an excess of entrances and others an excess of clearances. Those areas with an excess of entrances comprised in 1938 2, 6, 7, 8, 9, 10, 12, and 13; those with an excess of clearances comprised 1, 3, 4, 5, and 11; that is, Atlantic Europe and the Mediterranean, the Atlantic coasts of Africa and South America. Those areas with an excess of clearances were areas to which there was, until the late war, an export of British coal. Where this is absent or developed to only a limited extent, entrances with cargo invariably exceed clearances with cargo. The regional pattern of trade in 1950 displays significant differences from that in 1938. The decline in coal export has caused all-round decreases in clearances with cargo and trading areas which showed an excess of clearances over entrances with cargo do so no longer. Trade with Australasia alone shows an increase in cargo clearances and this is unrelated to coal.

The movement of vessels in ballast is complementary to that of vessels with cargo. Ballast tonnage includes tramps, which, having taken an outward cargo from a British port, but being unable to pick up a return cargo, find it more profitable to return to Britain unladen than to wait in a foreign port until a cargo becomes available. Ballast tonnage also includes tramps which, having brought a cargo from abroad to a British port and finding themselves unable to pick up an outward cargo, clear in ballast to foreign ports where cargoes are known to be available. Such movement in ballast on the second limb of a round voyage is more common on the near-continental trades than on the more distant routes. On the more distant routes tramps unable to obtain a return cargo back to Britain are likely to do some intermediate trading between foreign ports in order to work their passage home; such intermediate trading is unrecorded in Table CVI. Ballast tonnage is swollen further by passenger liners calling at British ports in the course of a voyage between, say, New York and Hamburg. Such vessels are recorded as in ballast if they land or embark passengers only. This accounts for part of the large ballast tonnage in both directions in areas 2 and 3, which include the continental ports of the English Channel and of the North Sea. It will be noticed that on the more distant routes there is much less movement in ballast than on the nearer, except on certain outwards routes. The exceptions are the Persian Gulf, the Atlantic coasts of North America, the West Indies, and Middle America; this tonnage is of tankers capable of carrying cargo only in a single direction. They are returning to the oilfields of Persia and Iraq, the Gulf of Mexico, and Venezuela.

The two maps prepared by the Admiralty attack the problem in another way. They display an instantaneous picture of British Empire shipping[1] at a particular moment of time. They show the

[1] They include Empire vessels as well as those registered in British ports, and they exclude vessels of under 3,000 tons gross, most of which are engaged on the coasting and near-continental trades.

massing of ships in port and along the main shipping lanes and, in the case of ships at sea, they show the direction of the voyage, outwards or homewards as the case may be. But these maps do not give any precise information of the terminus of the voyage. A vessel in the South Atlantic approaching Capetown, for example, may turn round at Capetown and return to Britain, or, after discharging cargo in a South African port, it may take a cargo of Natal coal to India or it may be bound for Australia, calling at Capetown or perhaps not at a South African port at all. Moreover, many of the vessels shown on these maps are engaged on voyages which do not involve calling at any British port and their movement is only indirectly the concern of an economic geography of Great Britain in so far as they employ British crews and contribute to the national income and balance of payments. The two maps refer to two different seasons—March and November. In March many of the seas of the Northern Hemisphere are still frozen and empty of shipping, but in November they are open. November represents the period of active shipment of seasonal cargoes in the Northern Hemisphere, March of seasonal cargoes in the Southern Hemisphere. In March 1936 St. John (New Brunswick) and Halifax (Nova Scotia) had thirteen vessels in port, while the St. Lawrence was frozen; in November 1937 St. John and Halifax had seven vessels in port, and the St. Lawrence twenty-three. Similarly, in March 1936 there were only two vessels in the Black Sea and none in Black Sea ports, but in November 1937 there were fourteen in the Black Sea and five in Black Sea ports. The maps give a most informative picture of world trade routes and are of great value in the analysis of world shipping, but it is with only one part of this vast canvas—the shipping traffic to and from Britain—that this chapter is concerned, and the Admiralty maps do not permit this to be isolated for examination.

After this general discussion of the shipping traffic of Great Britain, I will now turn to consider the traffic of British ports individually. There is space, however, to consider only samples. The ports of Britain vary greatly in the precise character of their traffic and in their precise function in the economic structure of the country. There are large general ports, such as London and Liverpool, with an extensive hinterland; there are small general ports, such as Newcastle, with a more localized hinterland; there are specialist coal-exporting ports, such as Blyth; and there are packet stations, such as Harwich and Dover. These multitudinous variations are related to the character and space-relations of the area served and are, of course, a direct reflection of the economic geography of Great Britain. They are not only a reflection of pre-existing conditions, for by reason of the facilities which they afford, they have actively encouraged or discouraged the economic development of their regional hinterland. Moreover, the commodities imported

TABLE CVII

Shipping of the Port of London, 1938 and 1950

(in million net tons)

		Arrivals			Departures		
		Cargo	Ballast	Total	Cargo	Ballast	Total
	A. 1938. *Foreign Trade*						
1	Eire	0·13	0·01	0·14	0·13	—	0·13
2	North Europe	4·21	2·23	6·44	2·86	5·58	8·44
3	Atlantic Europe and West Mediterranean	1·20	0·27	1·47	0·94	0·62	1·56
4	Central and East Mediterranean	0·88	0·11	0·99	0·27	0·19	0·46
5	West and South Africa	0·24	—	0·24	0·28	0·04	0·32
6	East Africa, Persian Gulf, and India	2·37	—	2·37	1·27	0·17	1·44
7	East Asia and Pacific	1·64	—	1·64	0·78	—	0·78
8	Australasia	2·41	—	2·41	1·22	0·02	1·24
9	North America–Atlantic coast	2·72	0·01	2·73	0·78	0·47	1·25
10	West Indies and Middle America–Atlantic coast	1·36	0·01	1·37	0·17	0·54	0·71
11	South America–Atlantic coast	1·07	—	1·07	0·86	0·03	0·89
12	South and Middle America–Pacific coast	0·14	—	0·14	0·05	0·01	0·06
13	North America–Pacific coast	0·96	—	0·96	0·14	0·10	0·24
	From or to other ports of United Kingdom	—	—	0·52	—	—	2·89
	Total Foreign Trade	19·37	2·64	22·52	9·76	7·77	20·42
	Coasting Trade	7·35	0·91	8·26	2·14	8·54	10 68
	Grand Total	26·72	3·55	30·78	11·90	16·31	31·10
	B. 1950.						
	Foreign Trade	14·18	3·31	17·49	10·12	7·09	17·21
	Coasting Trade	7·95	1·28	9·23	1·16	8·52	9·68
	Grand Total	22·13	4·59	26·72	11·28	15 61	26·89

have themselves given rise to new industries within the port and the existence of export facilities has attracted industries largely dependent on foreign markets.[1] The ports have thus been active agents in modelling the economic geography of Great Britain.

London is the largest British port, and will be taken as a sample of the large general ports of the country. It had 18·2 per cent of the foreign trade and 16·3 per cent of the coasting trade in 1938 of the total net tonnage arriving at and departing from all ports of Great Britain. But, although a large general port, its traffic is unbalanced in the sense that arrivals with cargo greatly exceed departures with cargo. This is true of both foreign and coastwise

[1] For specific examples, see W. Smith, *Distribution of Population and Location of Industry on Merseyside* (1942).

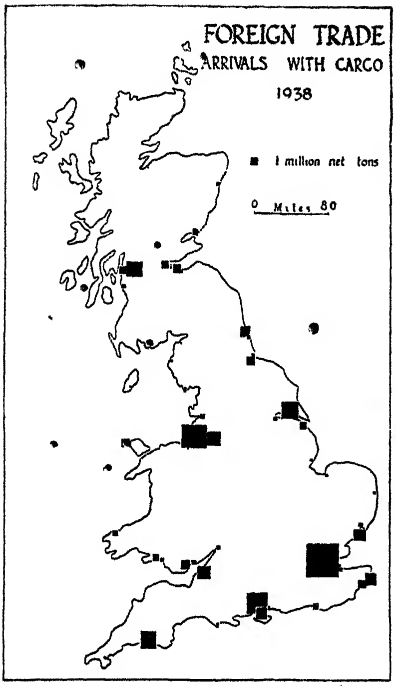

Fig. 86A

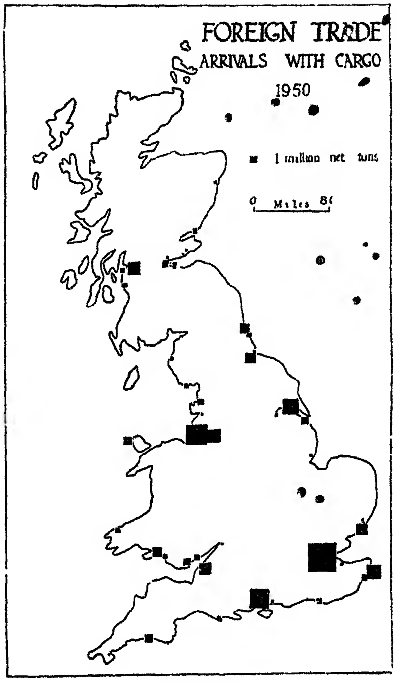

Fig. 86B

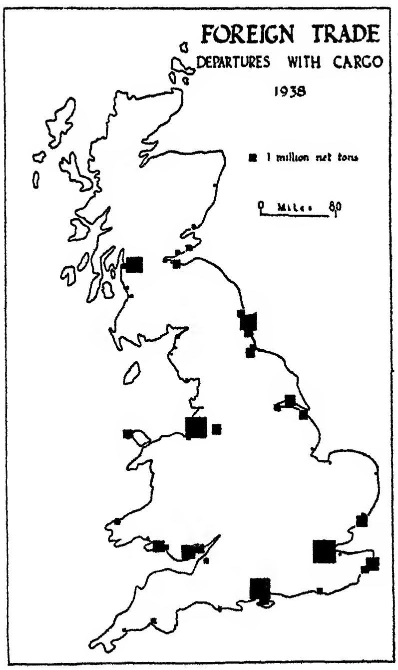

Fig. 86C

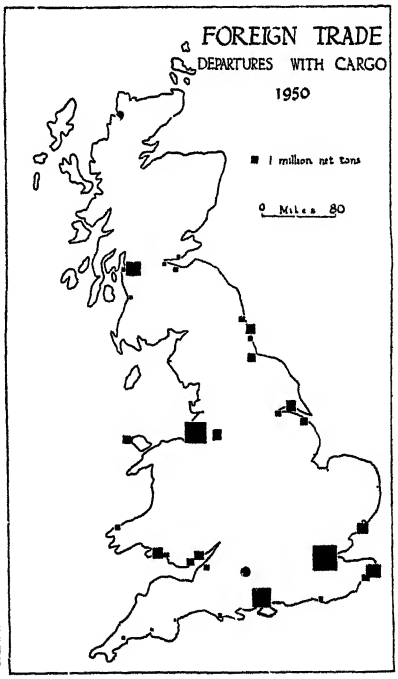

Fig. 86D

FOREIGN TRADE OF GREAT BRITAIN BY PORTS 1938 AND 1950

A, B, *Arrivals with Cargo.* C, D, *Departures with Cargo.*

trades. London is thus primarily an importing port.[1] The foreign trade returns, even though they are expressed in values and not in quantities, bear this out. In 1938 the imports of the Port of London were valued at £382 million, the exports (including re-exports) at £172 million. In 1948 total imports were valued at £673 and total exports at £507 million. This dominance of the import trade is a most significant fact in the economic geography of London.

The foreign and coasting trades are, up to a point, distinct from one another, but there is a certain amount of overlap between them, as shown earlier.[2] Neither the total foreign shipping nor the total coastwise shipping balance, when considered singly, arrivals exceeding departures in the one, but departures exceeding arrivals in the other. They balance only when considered together. Clearly, some vessels arriving at London in the foreign trade depart in the coastwise trade, and they swell the large ballast tonnage leaving London coastwise. It was by no means unusual for tramps, having left Britain with an outward cargo of coal from Cardiff or the Tyne, to return to London with grain and to depart again from Cardiff or the Tyne on a fresh outwards foreign voyage: if the whole of the grain is discharged in London, the voyage from London to Cardiff is recorded as coastwise. The inclusion of more than one British port in the course of a foreign voyage inwards or outwards is encountered frequently also among liners.[3] Some cargo liners depart direct to a foreign destination with cargo from a west coast port, such as Liverpool or Glasgow, and on the return voyage arrive at London as the first port of discharge, proceeding thence to other British ports to discharge the rest of their cargo.

The ballast tonnage, of course, balances the tonnage with cargo. Arrivals in ballast are comparatively small in quantity. From many parts of the world no vessels whatever arrive in ballast, the ballast tonnage arriving from the Atlantic coast of North America and the Atlantic coast of Middle America in 1938 consisting only of a single

[1] The corresponding quantities in 1913 were, in the foreign trade, 11·71 million tons arrivals with cargo and 8·29 million tons departures with cargo, and, in the coastwise trade, 5·73 and 2·34 million net tons respectively. The lack of balance between incoming and outgoing cargoes was present in 1913, but was somewhat less pronounced on both foreign and coasting runs. Lack of balance in the foreign trade was also less pronounced in 1950, overseas arrivals with cargo having declined while departures with cargo have increased both absolutely and relatively.

[2] The average net tonnage of vessels arriving with cargo in the Port of London is 572 from North Europe and 630 coastwise. The same type of vessel obviously takes part in both trades.

[3] If they carry some cargo in their holds from abroad or destined abroad in their voyage between British ports they continue to be recorded in the foreign trade; if they set down or take up cargo or passengers they are listed in the trade with a specific foreign area, but if they neither set down nor take up cargo or passengers they are recorded in the category, 'Arrived from Other Ports in the United Kingdom in the course of a Foreign Voyage Outward, or Departed to Other Ports in the United Kingdom in the course of a Foreign Voyage Inward'.

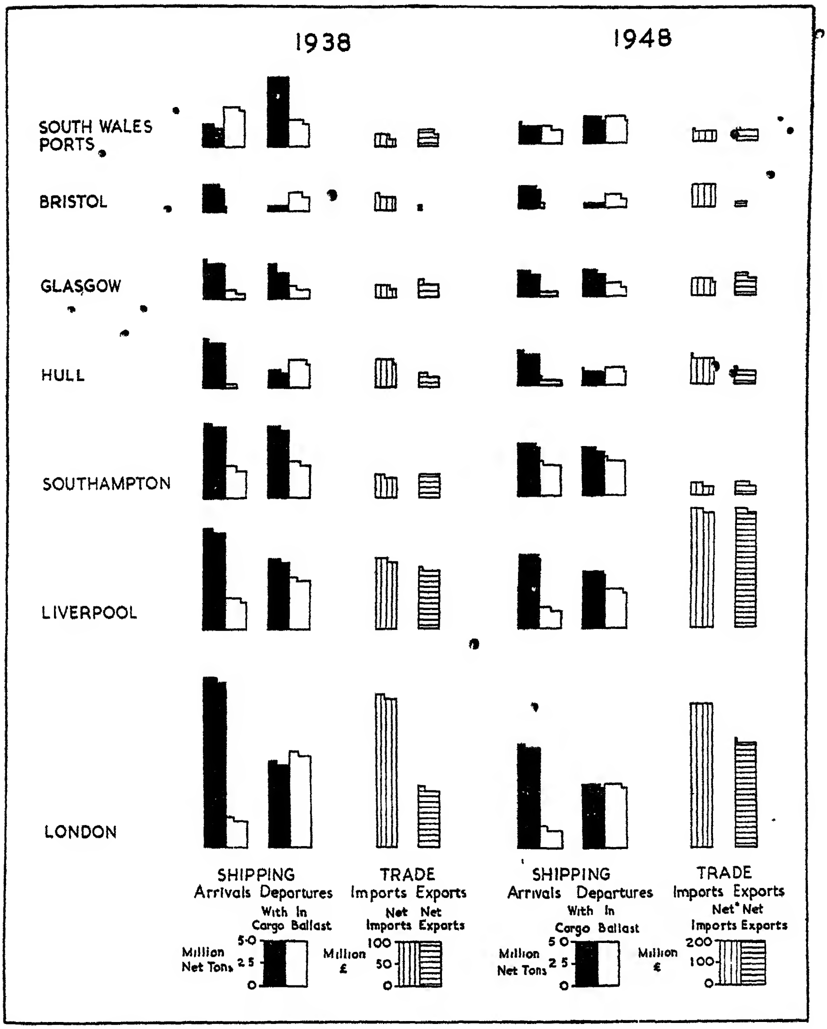

Fig. 87

SHIPPING AND TRADE OF SELECTED BRITISH PORTS IN 1938 AND 1948. FOREIGN TRADE ONLY

The height of the column is in proportion to the quantity of shipping tonnage and to the value of trade. It will be noticed that the shipping scale is identical at the two dates but that the trade scale in 1948 is double that of 1938 in order to make some very rough adjustment in money values.

vessel apiece. It is only from the European areas that any substantial quantity of ballast tonnage arrives. Some of this is of vessels engaged in the near-continental trade, but much of it consists of conspicuously larger vessels than those which arrive with cargo. This is, in fact, shipping of quite a different kind, for it consists of passenger liners or cargo-passenger liners calling at London to set down or pick up passengers in the course of a foreign voyage outwards from the Continent to, say, the United States or the Argentine. If they discharge or take up no cargo, they are recorded as arriving in ballast. The two vessels which arrived at London in ballast from Atlantic North and Middle America in 1938 were vessels of the same dimensions and were doubtless calling for the same purpose on the return trip. Departures in ballast from the Port of London on the foreign trade are very much greater than arrivals in ballast, and they depart to every trading area of the world except the distant one of Eastern Asia. Of the long-distance ballast voyages, many are of specialized vessels, such as tankers. The rest of the long-distance ballast tonnage consists of only occasional vessels, except in the traffic to the Pacific coast of North America, to which Britain can send few export cargoes to balance the large import of grain, timber, canned fish, and fruit. Departures in ballast to the European areas comprise the same elements as arrivals in ballast from these same areas.

As befits the largest port and capital city of Britain, London has trading relations with all parts of the world. But, by reason of her space-relations, some trading routes are more developed than others. Shipping trading with Ireland, with Atlantic Europe and the West Mediterranean, and with Atlantic North America in 1938 formed a smaller proportion of the total shipping arriving and departing from the Port of London than of the total shipping entering and clearing Great Britain as a whole. The restricted westerly space-relations of London are clearly marked. The proportion of total shipping trading with the North European ports was similar to that of the country as a whole and the easterly space-relations of London are clearly displayed. These space-relations are more clearly defined with the nearer than with the more distant fields of commerce. This is not surprising. There was a deficiency in London's proportion of shipping trading with West and South Africa when taken together, but the deficiency was with West and not with South Africa. There was an excess in London's proportion of shipping trading with Middle America and the West Indies, with the Atlantic coast of South America, and with the Pacific coast of North America. These excesses are in arrivals with cargo, for these areas provide the petroleum, grain, meat, and fruits which London imports in such large quantities. London has a very large proportion of the shipping trading with India (together with the Persian Gulf and East Africa), with Eastern Asia and the Pacific, and with Australasia. Of the total

arrivals with cargo and in ballast at all British ports, London had in 1938 30·5 per cent of those from India, 54·5 per cent from Eastern Asia, and 35·0 per cent from Australasia. These are the more distant trading areas, and traffic with them is the province of the larger ports. Much of the direct traffic to and from the Indian and Pacific Oceans is liner traffic and the regularized traffic of liners is the business of the large general ports. The commodity markets for tea, rice, and wool are all in London. The statistical returns of post-war years do not, unfortunately, permit a similar regional analysis for a recent date, either for London or for any other port.

Sharply contrasted with the general ports which, as a rule, now have more tonnage arriving with cargo than departing with cargo, are the coal-exporting ports. Some examples are given in Table CVIII. The analysis refers to 1938, when coal was exported in quantity. These characteristics will reappear if coal export is revived. As the analysis refers to these ports as coaling ports, the present tense has been retained. There are variations in the proportionate relationship of the several items at each port, depending largely on the extent to which they have traffic in commodities other than coal, but they have each certain characters in common. At each port departures with cargo exceed arrivals with cargo in both foreign and coastwise trade. This is the reverse of the relationship which obtains in the general ports. A purely coal port such as Blyth has scarcely any arrivals with cargo, but the larger ports of this group usually do some general trade[1] as well as a coal export business, though it will be noticed that at each port coastwise arrivals with cargo are very small indeed. The general cargo traffic coastwise is very largely the distributive trade of the large general ports, and the coal ports do not participate in it. The second characteristic is complementary to the first. All ports display an excess of arrivals in ballast over departures in ballast in both foreign and coastwise trade. The excess is invariably most pronounced in the coastwise trade. It is partly a complement of the small quantity of tonnage arriving coastwise with cargo, but it is due also to a third characteristic which these coalfield ports have in common. At each port total coastwise arrivals, with cargo and in ballast, exceed total coastwise departures. At each port in the foreign trade total departures exceed total arrivals. The grand total of arrivals and departures balances, but only when foreign and coastwise trades are taken together as a single unit. It will be remembered that the foreign trade of the large general ports displays an excess of arrivals over departures not only for vessels with cargo, but also for total shipping.[2] Tramp vessels arriving with cargo from abroad

[1] An import of pit props, ores, pig iron, or steel bars, for the industries of their hinterland and an import of grain or of provisions such as butter and bacon for the consumption of their industrial population.

[2] Southampton is an exception, but Southampton is a special kind of a general port.

TABLE CVIII

Shipping of some Coal Exporting Ports, 1938 and 1950

(in million net tons)

	Foreign trade			Coastwise trade			Grand Total
	Cargo	Ballast	Total	Cargo	Ballast	Total	
Cardiff							
1938 Arrivals	1·22	2·44	3·66	0·18	3·48	3·66	7·32
Departures	3·54	2·15	5·69	0·90	0·68	1·58	7·27
1950 Arrivals	0·92	0·52	1·44	0·22	2·06	2·28	3·72
Departures	1·07	1·02	2·09	0·87	0·76	1·63	3·72
Newport							
1938 Arrivals	0·29	0·68	0·97	0·15	1·21	1·36	2·33
Departures	1·60	0·24	1·84	0·19	1·29	0·48	2·32
1950 Arrivals	0·51	0·69	1·20	0·14	0·96	1·10	2·30
Departures	1·34	0·31	1·65	0·26	0·36	0·62	2·27
Swansea							
1938 Arrivals	0·83	1·28	2·11	0·13	1·14	1·27	3·38
Departures	2·45	0·52	2·97	0·20	0·23	0·43	3·40
1950 Arrivals	1·63	0·97	2·60	0·19	1·58	1·77	4·37
Departures	2·12	1·11	3·23	0·62	0·47	1·09	4·32
Tyne Ports							
1938 Arrivals	2·07	2·95	5·02	0·43	3·69	4·12	9·14
Departures	4·14	2·09	6·23	2·11	0·78	2·89	9·12
1950 Arrivals	1·68	1·01	2·69	0·25	4·57	4·82	7·51
Departures	1·77	1·83	3·60	3·06	0·95	4·01	7·61
Middlesbrough							
1938 Arrivals	1·28	0·64	1·92	0·12	0·94	1·06	2·98
Departures	1·67	0·52	2·19	0·38	0·42	0·80	2·99
1950 Arrivals	1·68	0·76	2·44	0·15	0·99	1·14	3·58
Departures	1·74	0·81	2·55	0·31	0·76	1·07	3·62
Blyth							
1938 Arrivals	0·02	0·61	0·63	0·01	2·02	2·03	2·66
Departures	0·89	0·05	0·94	1·62	0·09	1·71	2·65
1950 Arrivals	0·02	0·21	0·23	0·01	2·59	2·60	2·83
Departures	0·41	0·05	0·46	2·26	0·07	2·33	2·79

The differential pattern of change as between 1938 and 1950 is quite clearly displayed. There is a general shift from foreign to coastwise coal export, most marked on the North-east Coast.

discharge their cargo at large general ports and depart coastwise, usually in ballast. They are lost to the foreign trade for the time being. It is this tonnage which swells the coastwise arrivals in ballast at the coal-exporting ports, and it departs from them with a cargo of coal to a foreign destination.

These features are common to all the coal-exporting ports. They differ in the relative proportions of the foreign and coastwise trades. The coastwise trade in coal is most developed along the east coast, and especially from the ports of the North-east Coast coalfield. The coasting trade has been able to retain the long-distance coal traffic

from the north-east to London, but it has lost to the railway much of the short-distance coal traffic from South Wales across the Bristol Channel to the South-west Peninsula. These ports differ, too, in their space-relations. The trade of the east coast ports is eastwards, that of the west coast ports south-westwards. For Cardiff and the Tyne the regional distribution of departures with cargo is set out in Table CIX.

TABLE CIX

Destination of Departures with Cargo from Cardiff and the Tyne, 1938
(as percentage of total foreign trade from each port)

	Northern Europe	Atlantic Europe and West Mediterranean	Atlantic coasts of Americas	Other Areas	Total
Cardiff	2	60	31	7	100
Tyne	64	28	5	3	100

From *Annual Statement of the Navigation and Shipping of the United Kingdom* for 1938.

Figs. 86 and 87 permit a general comparison between the pre-war and post-war patterns of traffic movement overseas. The decline in overseas cargo departures from the coalfield ports is general: these ports have suffered less in cargo arrivals from overseas and a few have increased their arrivals with cargo. Decline in coal export, which these figures reflect, has implied less remunerative employment for outward-bound tramps. A second clearly defined change is a greater decline in the cargo arrivals of London as compared with those of Liverpool, a result partly of the persistence of war-time changes when the trade of London fell away to only small dimensions.

The shipping traffic of the packet-station ports, such as Dover and Holyhead, requires little discussion. It is usually a shuttle movement of specialized vessels on short sea voyages sailing backwards and forwards on a regular schedule between two ports. Such packet stations owe their existence to their sites at the shortest sea crossings, and their traffic is usually with a single foreign port in order to take full advantage of these shortest distances. The commodity structure of their trade will be considered in the next chapter.

The ports of the country compete with one another for the traffic of inland and coastal districts. Each port has a hinterland which is more or less well defined, but not rigidly defined. There is competition between ports around the margins of their respective hinterlands; for example, between London, Liverpool, Bristol, and Hull for the traffic of the Midlands. The extent of the hinterland, moreover, varies with the commodity. West Cumberland might well obtain

New Zealand butter through London or Liverpool, but it will import its iron ore direct. The large general ports have a more extensive hinterland in respect of commodities which are properly liner cargoes and a much more restricted hinterland in respect of tramp cargoes, especially when the complete tramp cargo can be consumed by a single port or factory. The nature of inter-port competition is in respect of land transport charges, of port charges, and of ocean freight charges. Competition in land transport charges has been considered earlier in this chapter. Ocean freight charges vary according to steaming distance and according to the balance of cargoes in both directions, for full cargoes in both directions permit goods to be carried at much lower rates than if a vessel had to make the journey in one direction in ballast. Variations in port charges are not unsubstantial. They are due partly to the varying physical character of each port. The open quays of Southampton with its four tides a day and maximum tidal rise and fall of only 13 feet are cheaper to construct and operate than the enclosed docks of Liverpool with a maximum tidal rise and fall of over twice that amount. Port expenses vary, too, according to efficiency in handling equipment, some small ports being very expensive because of antiquated appliances Loading into and unloading from lighters overside is a cheap method of handling bulky cargoes, and loading from and unloading on to the quay is cheaper if it can be direct from or into railway wagons or road lorries without intermediate dock-shed storage, involving double handling. The use of lighters is particularly prominent in the Port of London, where it has been encouraged by the Free Water Clause, but complaints are made that the quantity of lighters is so large that the movement of deep-sea shipping is impeded. The comparative costs of some twelve ports of Great Britain were investigated by a Committee of the Chamber of Shipping in 1923–4 in reference to standard cargoes. The range of variation between the highest and lowest for each standard cargo was 69 per cent or more, being 69 per cent for grain, 70 per cent for raw sugar, 79 per cent for ore. This range of variation for a cargo of grain amounted to 1*s.* 5*d.* per ton. At a railway rate of 1*d.* per ton-mile this is equivalent to a railway haulage of 17 miles. It will be interesting to observe whether the setting up of the Transport Commission under the 1947 Transport Act, will have an effect on these differences.

A new means of transport is developing in the air. It is independent of the configuration of the ground, though it is still more dangerous to fly in the vicinity of mountain than of lowland areas on days of low cloud and poor visibility, and it is affected by local winds, themselves modified by local relief. It is characterized by low unit loads, the actual load per aircraft on British lines in 1947 exceeding 2 tons only on the trans-Atlantic routes. Relatively low unit loads are likely

to remain a permanent characteristic of aircraft transport by reason of its inherent mechanical qualities. Such low unit loads imply selectivity of traffic. Bulk commodities such as milk and coal have been carried by plane, but only under exceptional circumstances when cost was not paramount. Passengers, mails and high-value commodities constitute the bulk of aircraft cargoes, mails contributing a larger proportion of the load on the longer distances than on the shorter. The number of passengers increases with the frequency of the service and this in itself reduces costs, because overhead costs can be spread over a larger traffic. Not only are aircraft themselves expensive, but airfields, which must for traffic reasons be in areas where suburban site values operate, involve very large capital expenditure in proportion to the traffic handled. Air transport is at present selective also in respect of distance and the stratosphere travel of the jet plane will further emphasize its long-distance character.[1] It is competitive with the railway and the liner, and these are, in fact, interested in the operation of air services. Air routes are yet main line in character, but they have not a traffic of main line density. It is this low traffic density which keeps costs so high and it is these high costs which repel traffic still further. Air transport can naturally develop faster in countries of continental dimensions than in relatively small countries such as Great Britain. The helicopter, however, may prove as useful for internal traffic within these islands as more normal but faster aircraft.

Air transport affects the surface of the earth only at terminal airports, which cover vast areas bigger than railway stations or sorting yards. They are located (in order to provide air approaches free of buildings) on the outskirts of the large towns and cities which provide passengers and cargoes, although the development of the helicopter may make airports, at any rate local or subsidiary airports, at once much smaller and more numerous. Because of the small number of passengers and the high value of the commodities carried, the direct effects of air transport on locating population and industry are comparatively slight at the moment. Air transport, however, may change very considerably in the future, and its effects on the economic geography of Great Britain, in addition to those of aero-engineering and aircraft assembly, may be more profound.

[1] R. O. Buchanan, Air Transport: Some Preliminary Considerations, *London Essays in Geography* (1951).

CHAPTER XV

FOREIGN TRADE AND THE BRITISH ECONOMY

AN analysis of foreign trade is not an appendage to, but an integral part of, an economic geography of Great Britain, for the population of the country is much too large for the practice of self-sufficiency and the British economy can function only if it can import food and raw materials and export finished manufactures. The chapter will endeavour to display the intricate interdigitation of home production and overseas trade in the structure of the British economy. The precise commodities and the precise quantities handled, determined in large measure as they are by the operation of the economist's law of comparative costs within the framework of the varied demands presented by a high standard of living, are by no means static, and they display clearly defined trends, cyclical as between trade-cycle crest and trough and long-term in harmony with changes in the structure of both British and world economy. The balance of commodities in British foreign trade was very different in the inter-war period from what it was when Britain was the workshop of the world during the nineteenth century, and it will doubtless be different again in the future from what it was in the inter-war period.

ANALYSIS BY COMMODITY AND GEOGRAPHICAL DISTRIBUTION

The analysis of the foreign trade falls naturally into two parts—an analysis according to commodities and an analysis according to geographical distribution.

The foreign trade of the United Kingdom, for the trade returns of Northern Ireland cannot readily be separated from those of Great Britain proper, expressed in values for the three major commodity classes, is set out in Table CX for three sample years, each representing a trade-cycle crest, together with the most recent year. Limitation of attention to conditions at trade-cycle crests greatly facilitates analysis.[1] Two other variables remain. There are variations in the precise areas covered by the trade returns, for the United Kingdom included the whole of Ireland in 1913, but Northern Ireland alone subsequently. Exclusion of Ireland, in order to limit the

[1] It will be recalled from Table CII above that there are marked fluctuations in imports of raw materials and in both import and export of manufactures as between boom and depression. Imports of food into Great Britain, on the other hand, were much more independent of boom and depression for the population had to be fed in bad times as well as good, until the operation of the controlled economy since 1939 which, by reason of food rationing and of changes in the structure of British farming, has caused a decline in food imports.

TABLE CX

Foreign Trade of the United Kingdom in Classes of Commodities, 1913–50

		Class I	Class II	Class III	Total
A. Values in £ million					
Retained imports	1913	279	206	172	659
	1929	509	285	305	1,111
	1937	418	278	250	953
	1950	1,009	941	551	2,518
Exports of British produce and manufacture	1913	44	66	414	525
	1929	56	79	574	729
	1937	39	65	405	521
	1950	135	105	1,882	2,170
B. Percentage of total trade					
Retained imports	1913	23·6	17·4	14·5	55·7
	1929	27·7	15·5	16·6	60·4
	1937	28·4	18·9	17·0	64·7
	1950	21·5	20·1	11·7	53·7
Exports of British produce and manufacture	1913	3·7	5·6	35·0	44·3
	1929	3·0	4·3	31·2	39·6
	1937	2·6	4·4	27·5	35·3
	1950	2·9	2·2	40·1	46·3

Total trade for the purposes of this chapter comprises retained imports plus exports of British produce and manufacture.

Class I—food, drink, and tobacco.
Class II—raw materials and articles mainly unmanufactured.
Class III—articles wholly or mainly manufactured.

The allocation of specific commodities to one or other of the three classes is by no means an easy matter. The food group includes manufactured provisions, manufactured tobacco, etc.; the raw materials group includes articles which are semi-manufactured and also scrap, the manufactures group includes, in addition to finished manufactures, articles requiring further treatment, such as cotton yarn and pig iron, in addition to finished manufactures. The items in the three classes do not add up to the total, the difference between the total and the sum of the three classes being parcel post and animals not for food.

returns to Great Britain, would require some estimation.[1] The last variable is the existence of difference of price-level as between the three years. Attempts are made to eliminate such differences in price-level by means of price indices, but although they are of very great value, they are not perfect instruments by any means.

[1] Some idea of the scale of adjustment necessary is given by the following percentage relations of the trade of Ireland to that of the United Kingdom. In 1937, for example, the ports of Northern Ireland received 1·1 per cent of the imports into the United Kingdom and contributed 0·7 per cent of the exports from the United Kingdom; Eire contributed 2·1 per cent of the imports into the United Kingdom and received 4·6 per cent of the exports from the United Kingdom; trade across the land boundary between Eire and Northern Ireland was responsible for 0·3 per cent of the imports into the United Kingdom and 0·3 per cent of the exports from the United Kingdom. In addition, an allowance would need to be made for the coasting traffic between Great Britain and Northern Ireland, but there are no commodity returns of this trade, though there are returns of shipping traffic.

The table displays in respect of values the general character of British trade as an import of foods and raw materials and as an export of manufactures. But in respect of weight (see Table CIV) the bulkiest export was coal in each of the sample years. Coal was of immense importance in shipping movement in providing outwards tramp cargoes, but it contributed to export values to only a limited extent. These elements provide the main framework of the foreign trade. The most important additional element is the import of manufactures, significant both in value and in weight, although over half the imports by weight are of refined petroleum.

The trends of British foreign trade as between 1913 and 1937 are of great significance in the delineation of the British economy. When sorted out by means of percentages, they are surprisingly clearly defined. As a *percentage* of total trade (excluding re-exports) imports of food, of raw materials, and of manufactures had all progressively increased and exports of foods and of manufactures had progressively declined, while the export of raw materials decreased to 1929, but remained steady afterwards. It may be concluded, therefore that by 1937, though not so clearly by 1929, the pattern of the foreign trade of Great Britain had changed considerably from what it had been in 1913. The excess of imports over exports had become emphasized still further, imports of each group of commodities had risen and exports of each group had fallen, both actually and relatively. But the proportions of trade came to be very different subsequent to 1945. Exports substantially expanded and imports declined, proportions in 1950 reverting to those of 1913. Restriction of imports is of foods and manufactures but not of raw materials. Expansion of exports is primarily of manufactures.

TABLE CXI

Classification of Retained Imports according to Use

(in £ million)

	1924	1929
Goods for use in industry	568	516
Goods for use in agriculture	34	32
Goods for use in building	46	46
Finished goods	489	518

From Colin Clark, *The National Income* (1932).

Let us look at the commodities involved in this trade a little more closely. Table CXI classifies retained imports according to the use to which they are put in the United Kingdom, whether they are in a form ready for consumption, as fruit or silk stockings or whether they are employed as raw materials or semi-products in agriculture, industry, or building. Though the proportion increased from 1924

to 1929, finished goods constituted less than half of the retained imports by value, the remainder being raw materials or semi-products of one kind or another. I have made a rough estimate for 1937 and 1950 on the same lines as the above calculation for 1929, and it would appear that the growth in the proportion of finished goods has certainly been halted and the trend reversed. The commodity structure of British foreign trade in 1937 and 1950 is set out in Table CXII. I propose to consider this structure in respect of its composition and of the balance of its several items.[1]

There was traffic in fish in both directions, but import in 1937 was chiefly of canned fish, (since restricted), while export was chiefly of cured and salted herrings. The one had become a common working-class dish and the other is a traditional export to Catholic Europe. There was an import of wine, but an export of whisky; an import of raw cocoa, but an export of manufactured cocoa; an import of raw sugar, but an export of refined sugar and of manufactured sugar confectionery; an import of tobacco leaf, but an export of cigarettes and pipe tobacco. There was an appreciable export of biscuits. Export of commodities in Class I was thus of manufactured foods, drink, and tobacco, made up in the British style. Some of these exports were processed from raw materials previously imported.

The trade in raw materials was equally specialized. There was little import to balance the export of coal or of china clay. There was an import of tin and copper ore; it is true that there are native ores of each of these in Britain but British tin and copper mining have suffered severely from the competition of more cheaply worked deposits abroad. There were, however, both imports and exports of iron, steel and non-ferrous scrap, though import and export were not to the same country. Exports of timber were very small and in 1937 half went to Eire; imports were very large and came from both temperate and tropical forests. Raw cotton, of course, was wholly imported, but there was an export, as well as an import, of cotton waste, the export in 1937 going to Europe and the import coming

[1] Economists have developed the theory of comparative costs to elucidate the structure of international trade and its relationship to agricultural and industrial production country by country. Each country specializes, so the theory runs, on the production of those commodities for which it has the greatest comparative advantages or the least comparative disadvantages. When international trade was in a rudimentary form of development, Britain might have imported only those commodities which she could not herself produce. But under the complex trading conditions of the modern world, Britain might well forgo (or limit) the production of one commodity which she could produce satisfactorily in favour of another commodity which she could produce better in order to develop an export in commodity B to a country which could produce commodity A as well as Britain herself and from which Britain might well import that commodity. International trade in this age must be reciprocal. Nor under the conditions of multilateral trade do complications in the structure of trade and of economy stop there. International trade is modelled not only by absolute resources, whether of materials or of skill, but also by forces, whether they be economic or political, arising out of the balance of the economy.

mainly from the East. There was an appreciable export of British raw wool, but it was of special qualities of the home clip, chiefly carpet wools exported to the United States, and there was an appreciable export of semi-manufactured wool, such as wool noils, to the Continent and the United States. The raw wool used in British mills, in addition to that from the home clip, is imported mainly from the southern continents. Raw silk, of course, was wholly imported. The exports of other textile raw materials included artificial silk waste and dressed flax, the products of industry rather than raw materials in an absolute sense. There was a large import of oil-seeds and some export of animal and fish oils, though import of tallow and whale oil exceeds export. The trade in hides and skins was chiefly inward, except in rabbit skins, and, where the same class of skin was both imported and exported, imports came from the Southern Hemisphere and the East, while exports went to the Continent and the United States. Of the paper-making materials, the bulk was imported, there being no export whatever of paper pulp, which provides the greatest quantity of paper-making materials. There was some export of rags and a substantial export of waste paper. Raw rubber, of course, was wholly imported in 1937, a date prior to large-scale synthetic manufacture, and the small export was almost entirely of reclaimed and waste rubber. Of the other raw materials, there was an export as well as an import of agricultural and horticultural seeds, some, such as clover, being exported in greater quantities than imported. There was an extensive export of tar and pitch, a by-product of gas-making. While the bulk of commodities in the food and raw materials groups were thus imported, there were exports of British produce and manufacture within these same groups. Although the range of commodities was very wide, the great majority nevertheless belonged to a few well-defined types. The first was of foods and raw materials of which Britain has ample resources, such as coal, fish, china clay. The coal and the clay are bulky materials and export was entirely, or almost entirely, from coastal districts. There was a second type of raw material, such as carpet wools, which are in demand abroad. The third was of manufactured or semi-manufactured commodities, such as refined sugar, biscuits, or cigarettes, sometimes made from materials imported in their raw state. The fourth was of waste products, such as rags, waste paper or scrap, accumulated by a densely peopled and urbanized country. The general conclusion may be drawn that the foods and raw materials produced within Britain are mostly required by the British population and by British industry, that only a small range of specialities is available for export, and that exports within the foods and raw materials groups (apart from a few exceptions such as coal and fish), are chiefly manufactures or semi-manufactures. This examination of the composition of

TABLE CXII

Commodity Structure of British Foreign Trade in 1937 and 1950

(as per cent of total trade)

For the purpose of this table, total trade is retained imports plus exports of British origin.	1937		1950	
	Retained imports	Exports of British origin	Retained imports	Exports of British origin
Food, drink, and tobacco:				
Grain and flour	6·07	·12	2·40	·07
Fresh fruit and vegetables	2·38	·03	2·06	·02
Live animals for food	·48	·01	·43	—
Meat	5·86	·08	4·16	·02
Animal feeding-stuffs	·77	·04	·34	·01
Dairy produce	4·88	·08	3·30	·05
Other food	3·87	·88	3·79	1·28
Beverages	2·84	1·05	2·68	1·01
Tobacco	1·19	·34	1·36	·41
Raw materials and articles mainly unmanufactured:				
Coal	—	2·56	—	1·06
Other non-metalliferous mine and quarry products	·33	·09	·38	·08
Iron ore and scrap	·86	·06	·84	—
Non-ferrous ores and scrap	1·25	·22	1·03	·03
Wood and timber	4·17	·01	1·99	—
Raw cotton and cotton waste	3·17	·07	3·40	·04
Raw wool, waste and rags	2·56	·62	3·46	·59
Raw silk, knubs and noils	·15	—	·05	·06
Other textile materials	·81	·04	·75	—
Seeds and nuts, oils, fats, etc.	2·34	·26	4·43	·13
Hides and skins	·92	·12	·82	·04
Paper-making materials	1·08	·13	1·13	·03
Rubber	·54	·03	1·09	·03
Others	·73	·20	·69	·15
Articles wholly or mainly manufactured:				
Coke and manufactured fuel	·01	·28	—	·23
Pottery, glass, abrasives	·56	·68	·11	1·15
Iron and steel manufactures	1·34	3·28	·53	3·33
Non-ferrous metals and manufactures	2·86	1·07	2·33	1·64
Cutlery, hardware, instruments	·47	·66	·18	1·07
Articles wholly or mainly manufactured:				
Electrical goods and apparatus	·27	·85	·09	1·79
Machinery	1·58	3·37	·94	6·76
Manufactures of wood and timber	·56	·09	·25	·05
Cotton yarns and manufactures	·21	4·65	·61	3·38
Woollen and worsted yarns and manufactures	·24	2·41	·48	3·00
Silk yarns and manufactures	·16	·10	·25	1·07
Other textile manufactures	·51	1·38	·35	·65
Apparel	·54	·69	·18	·76
Footwear	·17	·15	·05	·21
Chemicals, drugs, etc.	·91	1·68	·75	2·29
Manufactured oils, fats, resins	3·01	·40	2·70	·43
Leather and manufactures	·58	·36	·29	·34
Paper, cardboard	1·16	·55	·64	·60
Vehicles	·42	2·71	·39	8·68
Rubber manufactures	·05	·12	—	·18
Others	1·40	1·99	·62	2·53
	100·00		100·00	

British exports in Classes I and II emphasizes still further the specialist character of British exports as made up of manufactured commodities, the product of British industry and labour rather than the direct product of the British soil. From the point of view of world trade, Britain is an industry state and not, except in certain specialities, a raw materials state. It is concerned with secondary and not with primary production.

The third class (Class III of Table CX) of commodities—articles wholly or mainly manufactured—was involved in both imports and exports. In the aggregate the balance of trade was outwards and this was true also of the greatest number of individual commodities within the class. Those in which import exceeded export were non-ferrous metals and manufactures, manufactures of wood and timber, paper and cardboard, oils and fats. Those in which export exceeded import were iron and steel, machinery, vehicles, cutlery, hardware, instruments and implements, electrical goods and apparatus; textile manufactures of all kinds and apparel; pottery and glass, chemicals and drugs, rubber manufactures, and in 1950 leather and footwear. Excess of exports was thus most pronounced in those vast congeries of industries, metal and textile manufactures, which have been the staple of British industrial production from medieval times, and which expanded enormously during the Industrial Revolution. It is true that there had been changes in relative balance of export between the separate items within the metal group and between the separate items within the textile group, but in the aggregate they remained the chief British exports and the foundation of the British industrial economy. They helped to model directly the pattern of the import trade, for almost exactly half the import of raw materials in 1937 and over half in 1950 was of raw materials for their sole use, and a large proportion of the food import is to feed the workers in these industries, their dependents, and their ancillaries. Of those manufactured products other than metals and textiles, exports exceeded imports in some, imports exceeded exports in others. Some of these are ancient British industries, such as leather, footwear, and pottery manufacture; others are relatively new industries, such as chemicals and rubber; and others again, although of long standing, are virtually new industries in the present scale of their output. These are not the primary industrial specialisms of Britain and some have developed relatively recently to supply a primarily home market at a time when Britain's industrial supremacy is less outstanding than formerly.[1] The aggregates for each of the industries discussed above are set out in Table CXIII. Let us look at the individual items involved in this trade in finished manufactures a little more closely in

[1] Although a new industry, chemical manufacture has developed a large bulk of output and a large export trade, partly on the basis of British salt, as a result of conscious effort and of some degree of protection accorded to an infant industry.

respect of the extent to which there was overlap between import and export, and in respect of the ways in which this trade reflects the character of the British economy.

TABLE CXIII

Foreign Trade in Articles wholly or mainly Manufactured, 1913–50

(in £ million)

	Metals	Engineering	Textiles	Refined Petroleum	Other manufactures	Total
Retained imports:						
1913*	40	12	40	10	92	194
1929	64	34	51	36	121	305
1937	69	33	17	41	90	250
1950	142	67	79	117	146	551
Exports of British produce and manufacture:						
1913	69	62	178	—	103	411
1929	96	118	217	3	140	574
1937	74	102	126	3	100	405
1950	283	808	379	13	399	1,882

* Total imports, including imported merchandise not retained in the United Kingdom.

The pottery, glass, and abrasives group was a composite one. Exports exceeded imports in all classes of pottery—tiles, sanitary and electrical ware, crockery, earthenware and refractory goods. The only exception was bricks, some of which were imported on the short sea voyage from the Low Countries, which was presumably no more expensive than a long rail journey. In 1950 exports of glassware greatly exceeded imports, but in 1937 imports had exceeded exports, especially in table and illuminating glassware, which was imported from the Continent, though in plate-glass the excess of imports was less and in glass bottles export had equalled import. The manufacture of crockery and of earthenware is an older British industry than the manufacture of glass, though Britain is by no means short of glass sands. The branches of glassware which have developed furthest in Britain are those of plate-glass and glass bottles, heavier branches of the industry than the table-ware in which continental countries have specialized.

The composition of the import and export of iron and steel manufactures is of very great interest. In the nineteenth century, and as late as 1929, Britain was an exporter of pig iron on a substantial scale, but by 1937 imports exceeded exports, and they still do so.[1] There was during the inter-war period a considerable import

[1] Import is still substantial owing to industrial demand for steel exceeding steel output.

of blooms, billets and slabs, and of bars and rods, in the aggregate exceeding exports. This import, however, had decreased in the 'thirties owing to the effects of the Import Duties Act of 1932 and of the reorganization of the iron and steel industry subsequent to the Great Depression. Imports exceeded exports also in girders, beams, joists, and pillars. From this point a marked change developed in balance of import and export. There was a large export of steel plates and sheets, of iron plates and sheets, and of galvanized sheets, amounting in 1935 to one-sixth, over one-half, and over two-thirds respectively of the output within Great Britain. In rails, both railway and tramway, export again substantially exceeded import, and export was itself a quarter of total output in 1935. Plates, sheets, and rails are all heavy products, but—and this is a very significant point—they are finished products, unlike the pig iron, the blooms, billets and slabs, and the bars and rods, which are semi-finished, requiring further manufacture. The British steel industry may have imported semi-products to supplement its own output, but it exported in large quantities the finished products ready for the consumer. The excess of export over import was true of almost every other form of finished iron and steel—foundry work, tinplate, hardware and hollow-ware, chains, springs, nails, nuts and bolts, wrought iron and steel tubes, tools and implements, cutlery, most forms of wire, and some kinds of needles and pins. Only in a few specialized products, such as hosiery needles, did home production fail to supply by far the greater part of the home market.

The relative balance of import and export in machinery was more complicated. In the aggregate, exports far exceeded imports, but in certain kinds of machinery imports were greater than exports in 1937 though by 1950 trade had been reversed, in refrigerators, for example. Whenever exports were large and imports negligible, as in locomotives and mining and textile machinery, export constituted a large proportion of output and, conversely, whenever imports were large and exports negligible, home production satisfied only a small proportion of the home market. These are the effects of industrial specialism and of lack of industrial specialism respectively. Shipbuilding is an even more striking example. Only small craft, such as Dutch motor-vessels for the near-continental trade, were imported in the inter-war period. Not only do British shipbuilding yards supply the needs of British ship-owners, but there is also a substantial tonnage built on foreign account. This is now also true of motor-cars and cycles, of aircraft and aero-engines, though it has not always been so of motor-cars. These have become British industrial specialisms, though conscious state protection as infant and strategic industries has been partly responsible for their growth.

The textile industries, even more than iron and steel, are a prime basis of British industrialism. Their relative importance was even

more outstanding in the past than at the present day. British iron manufacture has been circumscribed once before in the decades preceding the development of coke-iron manufacture when imports of pig and bar iron exceeded exports, but until the twentieth century there had been no qualification to the dominance of the British textile trades. In all textile manufactures, except silk, trade is predominantly export. Raw materials, it is true, are imported in large quantities: this includes not only tropical fibres, such as cotton and hemp, which Britain cannot itself produce, but also animal fibres, such as wool, and vegetable fibres, such as flax, which are produced within the British Isles. This import of raw materials is comparable in nature to the import of iron and non-ferrous ores and semi-products. British spinning-mills produced in 1935 99·9 per cent of the cotton yarn used within Britain, but in addition there was a not unsubstantial export, amounting to 11·5 per cent of output in that year. The proportion of export to output increased steadily with increasing fineness of yarn, export of yarns of under 40's being in 1935 8 per cent but of yarns of over 120's being 75 per cent of output. British weaving sheds in 1935 made 98 per cent of the cotton cloth consumed by the British market, and even in that year exported 65 per cent of output.[1] The proportion of cotton cloth output exported had been much higher at earlier dates. It is clear that in cotton the more elaborate products embodying the greater labour, that is, piece goods, are exported to a greater degree than the less elaborate products embodying the less labour, that is, yarn. Owing to temporary circumstances which were not present in the eighteenth century and which have now passed away, the proportion of output exported was greater among the cheaper classes of cotton cloth, that is, grey unbleached, but the export of the cheaper cloths has declined faster than the export of the dearer cloths and is now of only small dimensions. The British wool textile industry also satisfied by far the greater part of the requirements of the home market—in 1935, 99·7 per cent of the market for yarns and 98·7 per cent of the market for tissues. There was also a larger export of tissues than of yarns when expressed as a percentage of output, being in 1935 26·8 and 9·3 per cent respectively. The more elaborate products embodying the greater labour were again exported in the greater quantities. The proportion of output exported, however, was less than that of cotton piece goods. The linen and hemp industries displayed essentially similar conditions, though they were perhaps not quite so clearly defined. They satisfied practically the whole of the home market, though the percentage was a little less than in the case of cotton and of woollen and worsted. The proportion of output exported was again greater in the more than in the less elaborately fashioned products; in piece goods and in linen thread than in line and tow yarn. Jute showed

[1] As measured in linear yards in each case.

precisely the same conditions, though they were again less clearly marked. In the silk industry there was a different balance. The home market for silk pieces was supplied mainly by import, but for artificial silk pieces mainly by home production. The British silk industry was thus not an industrial specialism of Britain to the same extent as cotton, woollen and worsted, linen, jute, and perhaps artificial silk. On the whole, the textile industries, like the metal industries, export a larger proportion of their more elaborate products, which embody the maximum amount of fashioning by British labour.

The trade in apparel, like the trade in machinery, is a flow in both directions, but in 1950 it was predominantly outwards. In 1937 exports had exceeded imports in mackintoshes and in men's clothing, but there was almost equal traffic in and out in women's clothing and in hats and caps: imports had exceeded exports in all kinds of gloves except woollen gloves: and, while in 1950 exports were greater in woollen and cotton stockings, imports were greater in silk stockings. The woollen and cotton tradition of British manufacture has clearly defined effects.

In the leather industry the raw material in the form of hides and skins is largely imported, but the home market for undressed and dressed leather is supplied largely by British manufactures, the percentage of the home market supplied by British manufactures in 1935 being 82 for undressed and 76 for dressed leather. The proportion of the output exported in 1935 was 7 per cent for undressed leather and 20 per cent for dressed leather. The quantities exported, however, were less than imports in each case in 1937, but exports of dressed leather were the greater in 1950. The British boot and shoe industry supplied almost the whole of the home market—98·7 per cent of boots and shoes made of leather in 1935. Foreign trade in boots and shoes is of only small dimensions, partly because of the existence of national styles[1], and this restricted trade displayed an excess of exports in quantities and values in 1950, but in quantities only in 1937. Exports were of men's, women's, and children's shoes sent largely to English-speaking countries abroad, but imports were wholly of women's shoes of higher value, pair for pair, than exported women's shoes.

The trade in manufactures of wood and timber was primarily import. Great Britain has a great deficiency of timber, as both wars of this century have shown, and timber manufactured in bulk is more conveniently handled at the point of felling owing to the very considerable loss of weight involved, as well as to the relatively high weight in proportion to numbers employed and to the relatively low value per ton. It is an industry closely fixed by the provenance of raw materials and so scattered in the woods of America and Europe. Britain has long imported timber in the form of planks, spars, and

[1] There are differences in style even as between English and Scottish shoes.

props, but there is now as well a large import of finished woodwork in the form of furniture, and especially of plywood from the forested regions of North America and Northern Europe.[1] The small export from Britain was chiefly of furniture sent to English-speaking countries abroad. The trade in paper is very informative. Those forms of manufactured paper which were imported, apart from paper pulp classified as raw material, included newsprint, packing and wrapping paper, and boards of all kinds. These are the relatively coarse and bulky sorts which are most conveniently manufactured at the point of the raw material. The manufactured paper exported consisted of the more highly manufactured forms—printing paper (other than newsprint), blotting paper, wallpaper and coated papers, stationery and playing cards. The only highly manufactured forms mainly imported were cigarette papers. Wherever the same kind of paper was both imported and exported, exports were in most cases higher in value weight for weight and presumably consisted of the better qualities.

From this general survey of the trade in manufactured goods, of which only samples have been treated, it may be concluded, first, that imports and exports within the same commodity group usually consist of quite different items, import being frequently of semi-products and exports being usually of the more finished forms of manufacture. As an industry state, Britain lives on the products of British labour, and, as the more finished forms of manufacture incorporate the results of British workmanship to a maximum extent, their export contributes more successfully than the exports of semi-products to the British economy.[2] From this point of view the import of semi-products is not in itself unreasonable, nor an instrument undermining the British economic structure; it becomes such only if these semi-products can be made more satisfactorily within Britain from British materials, than abroad from foreign materials. The second conclusion is that the major industrial specialisms of Britain are the manufacture of metals and of textiles, together with their derivatives. Although these now draw extensively on imported raw materials, they were originally based wholly on home produced raw materials. Ores of iron, tin, copper, and lead, are all worked, or have been worked, within Britain, and British wool and flax form the original basis of British textile manufacture, cotton and jute being grafted on to these original stems at a comparatively late date. As they have grown in bulk, they have imported raw materials to supplement home production and, in the case of several of the metal industries, have begun to import semi-products in addition.

[1] There was also an import of builders' woodwork before 1939.

[2] This point is developed in respect of the leather and boot and shoe trades by Dr. E. C. Snow in the discussion on H. W. Macrosty's paper in the *Journal Royal Statistical Society*, vol. CIII (1940), p. 483.

After this analysis of British foreign trade according to commodity, let us now look at its geographical distribution. There is a good deal of fluidity from time to time in this respect, as Chapter III has shown. The nineteenth century exhibited a gradual expansion of Britain's trade both in quantities and in geographical range, and a gradual change in the balance of its distribution, the dominance of the European theatres of trade gradually diminishing and the importance of the Eastern and Southern Hemisphere theatres of trade gradually increasing. Shifts of this kind were obviously due to the economic development of the East and to the settlement by peoples of European stock of the continents of the Southern Hemisphere. The nineteenth-century economy of the southern continents was based on primary production for European markets. Shifts in balance of trade have developed in the twentieth century as a result of the same sort of long-range development. High prices in one country will drive trade away to countries where prices are lower: such shifts may be temporary, if due to manipulation of exchanges, but they may be long-term, if a reflection of the economic structure of the country. But there are also shifts of more limited duration due to more temporary causes. A failure in harvest in, say, wheat in one country leads to import of the same commodity from another country forming an alternative supplier. Political factors also have their effects. Autarky[1] restricts foreign trade and the trade restrictions imposed on Italy as sanctions at the time of the attack on Abyssinia greatly reduced trade between Great Britain and Italy.

The trade with each major group of countries for the identical years employed in Table CX for the commodity analysis is set out in Table CXV. Each group of countries specified in the table has certain common internal characteristics, whether they be economic or political, and it will be seen that the trend of total trade and the balance as between imports and exports have both varied from group to group. Though valuable for comparison of items within a particular year, the returns in the form of values are not as suitable for comparison between different years owing to differences in price-levels. Percentages have therefore been calculated in order to compare one year with another.

The trade with industrial western Europe, France, Germany, Netherlands, Belgium, Luxembourg and Switzerland, is of very large dimensions. It is a trade between neighbours and on these grounds alone it is to be expected that it would be substantial. Moreover, adjacent highly industrialized countries develop specialization on different kinds of finished production in the same way, though not to

[1] Autarky could be a policy designed on primarily economic grounds, but the more complete attempts at it have a political rather than an economic basis. Professor A. G. B. Fisher develops the thesis that autarkic economies are parasitic and that any success they may achieve 'is strictly conditional upon other parts of the world not following their example' (*Economic Self-Sufficiency* (1939)).

the same extent, as regional specialization within an industrial country. Although a trade with neighbours, it has tended to decline, both actually and relatively, to Britain's trade as a whole. It will be recalled from Chapter III that Britain's trade with Europe was declining relatively as a percentage of Britain's total trade before 1913. A *relative* decline was to be expected with the continuing economic development of other parts of the world, but it has been heightened by policies designed to increase national self-sufficiency on the part of several states within this group. Britain's trade with Western Europe has long been unbalanced, imports exceeding exports, but the degree of unbalance has declined and is now no more than that of imports and exports as a whole. The decline of imports was due partly to the Import Duties Act of 1932 and, more recently, to the conditions of post-war Germany. The trade between Britain and these industrial countries is by necessity very largely a traffic in manufactures. Of the total retained imports into Britain in 1937 from industrial continental Europe, nearly 60 per cent were commodities in Class III (articles wholly or mainly manufactured) of the classification adopted by the *Annual Statement of Trade*, whereas only 17 per cent of retained imports from all countries were commodities in Class III. To put it another way, these countries in 1937 supplied 37 per cent or the total retained imports of manufactures into Great Britain, but only 17 per cent of retained imports of all classes of commodities. Britain exports manufactures and coal in return for these imports, but, while for individual countries such export equalled or exceeded retained imports of manufactures, it did not do so in the aggregate for the whole group.

Trade with Scandinavia, with South Central Europe and with East Continental Europe (the U.S.S.R., Poland, and the Succession States) was of a different nature. There are, in fact, two Europes—a conception developed in 1929 by F. Delaisi, in his book *Les Deux Europes*. There was little import of manufactures, but a large import of foods and raw materials. Trade with East and North Europe displayed the general commodity structure of British trade. The precise balance of trade varies from country to country and from time to time. It was much more nearly balanced in 1950 (as a result of restraint of imports and encouragement of exports) than in 1937, except in the trade with the U.S.S.R. and its satellites, whereas in 1937 it had been unbalanced with every country. Trade with Mediterranean Europe and with the Asiatic and African shores of the Mediterranean also displayed the same commodity structure as trade with Northern and Eastern Europe, but it was much more nearly balanced. In 1913, indeed, exports had exceeded imports and there had been a favourable balance of visible trade with Mediterranean Europe. These countries were dependent on British manufactures and British coal to a much greater extent than the rest of

Europe, although the degree of their dependence was diminishing. While exports contributed 51 per cent of the total trade with Mediterranean countries in 1913, they constituted no more than 40 per cent in 1937, though it had recovered to 47 per cent in 1950.

The trade with North America was rapidly changing. From the point of view of world trade the United States is ceasing to be a primary producer with a large surplus of foods and raw materials to export, and is becoming more and more an exporter of finished manufactures. Full employment in the United States, like full employment in Britain, is held to require a large export of finished manufactures abroad and the United States, which had imposed a severe tariff on imports of manufactures during the inter-war period, is now becoming interested in the removal of trade barriers and in an increase in the total volume of world trade.[1] In 1937 import of United States manufactures by Great Britain was greater than the import of United States foods or raw materials. Exports of British manufactures to the United States have come to be considerably less than imports of United States manufactures into Britain. In many respects Canada is taking the place of the United States as an exporter of primary production. This has already developed in the case of wheat and timber products. But Canada herself is becoming an industrial country, and in 1937, though not in 1948–50, Britain's import of manufactures from Canada actually exceeded export of British manufactures to Canada. Canada has to make the decision in framing her economic policy, whether to remain a primary producer with a large export abroad or to become an industrial country in addition, which would mean that the exchange of primary products for manufactures would be disrupted. It is the old dilemma under conditions of well-developed international trade that industrialization, in bringing economic benefit to the industrial population, frequently brings in its train economic distress to the farmer.

Trade with the rest of the Americas was, on the whole, of a different nature. With the tropical Americas it was tolerably well balanced. Exports considerably exceeded imports in 1913, but they no longer did so in 1937, partly because of the increasingly large import of petroleum and partly because of the encroachment of United States manufactures in markets formerly supplied from Britain. Between 1913 and 1950 percentage of imports increased

[1] For example, the report entitled *The United States in the World Economy* (1943), by H. B. Lary of the United States Department of Commerce. It is realized, however, that American exports are possible on a large scale only if the United States imports from foreign countries in return and/or if the United States invests American capital abroad. The necessity of imports in the form of foods or raw materials or interest on capital invested abroad is expressed more forcibly still by Professor A. H. Hansen in *America's Role in the World Economy* (1946). Although this is realized by American economists, it does not follow that it is necessarily the policy of U.S. business or the U.S. Government.

but percentage of exports fell. Trade with temperate South America has long been unbalanced, imports greatly exceeding exports. Manufactures and coal were exported from Britain, but imports of food and raw materials greatly exceeded them. Uruguay and the Argentine are at present primary producers whose economic development has been with the aid of foreign capital, largely British in origin, and imports in effect represented interest on this capital. But the economy of the Argentine is undergoing change.

Trade with British South and Tropical Africa has expanded steadily since 1913 in both imports and exports, and both actually and relatively. This trade, moreover, was predominantly export, except with British Tropical Africa. The exclusion of gold, however, has much to do with the creation of this favourable visible balance. Trade with non-British Tropical Africa, fluctuates from period to period. Exports greatly exceeded imports in each year, but the quantities involved were small.

Trade with India, Burma, and Ceylon had expanded greatly during the nineteenth century, particularly during its second half. Expansion ceased after 1913, making allowance for differences in price-levels. Imports into Britain fluctuated, but exports from Britain fell continuously, especially after India acquired fiscal autonomy. India has developed cotton and steel industries in turn to supply the Indian market with finished goods formerly manufactured in Britain, and India even exports some semi-products, such as pig iron, to Britain itself. Though it was expanding in the 'twenties, trade with South-east Asia and with China contracted in the 'thirties. Trade with Japan shows with remarkable clarity the effects of the growing industrialism of that country, which were the more pronounced because of the rapidity with which that industrialism was adopted. In 1913 exports from Britain greatly exceeded imports into Britain—the normal relationship in Britain's trade with a non-industrial tropical or warm temperate country. Thereafter, imports from Japan steadily increased and exports to Japan as steadily declined. With the industrialization of Japan, British manufactures were needed to a much lesser extent, and Japan herself began to develop an export abroad. Imports from Japan now exceeds exports.

The trade with Australia and New Zealand is a large one, which was steadily expanding in relative importance and in actual values alike, apart from some recession in exports from Britain in 1937. But, while total trade expanded, it had been more pronounced in imports, so that, while exports just exceeded imports in actual values in 1913, imports substantially exceeded exports in actual values in 1937. This change in the balance of trade was the result of the continued growth of primary production, together with the industrialization of Australia with consequential restrictions in the import

of manufactures from Britain. Trade balanced again, however, in 1950.

If this classification of regional groups and types of countries be simplified still further, the general conclusions to be drawn up to 1937, or up to the eve of the war, are these. The first is that Britain had a large but essentially unbalanced trade with the industrial countries of Europe and North America. There was a mutual exchange of finished manufactures between Britain and these industrial countries, although in the aggregate Britain imported more manufactures than she exported, but the huge excess of imports was due to foods and raw materials from those countries which were not wholly industrial. In the aggregate, despite exceptions in respect of individual countries, this trade with highly industrialized countries was tending to decline rather than to increase, and the sharp contrast between imports and exports was tending to become slightly less pronounced. The second general conclusion is that trade with the tropics, until the 'thirties, was unbalanced in the aggregate in the reverse sense, exports from Britain exceeding imports into Britain. Even in 1937 the excess of exports was still true of some trading areas, although imports exceeded exports in the aggregate. Apart, from the Indian group, trade with these tropical lands has grown, although there was a falling away in some areas, especially in exports, during the 'thirties. Trade with the tropics had been increasing up to 1913, and at that time exports to India and the Far East were also increasing. The great decline of exports to India was subsequent to 1913. The third general conclusion is that trade with the Dominions, including Newfoundland, but excluding India, Burma, and Ceylon, had increased steadily from 11·9 per cent of retained imports and 17·7 per cent of exports of British produce and manufacture in 1913 to 23·5 and 25·7 per cent respectively in 1937. This represented an actual, as well as a relative, growth, and was true of exports as well as of imports. But there was a clearly defined change in the balance of imports and exports with the Dominions, except in the trade with British South Africa, for in actual values exports were the greater in 1913, but imports the greater in 1937. The distinction between trade with the Commonwealth and with Foreign Countries is set out in Table CXIV. Eire has been omitted in order to permit comparison with 1913. The increase of the Commonwealth trade is clearly marked, especially in respect of imports. In terms of total trade (retained imports plus exports of British produce and manufacture), trade with the Empire had increased greatly in imports and had remained steady in exports, while trade with foreign countries had declined conspicuously in exports, but had remained relatively steady in imports. These differential changes between 1913 and 1937 as between Commonwealth and Foreign Countries were due partly to the operation of Imperial Preference, but they also antedated the Import

Duties Act and the Ottawa Conference of 1932 and cannot by any means be ascribed wholly to this cause. It may be inferred from the table that the changes between 1929 and 1937, which embodied the effects on Imperial Preference, were more conspicuous in imports than in exports, in other words, that the redistribution of trade consequential on Imperial Preference benefited the Dominions to a greater extent than it benefited Great Britain. A precisely similar conclusion is arrived at by Prof. J. H. Richardson from a more detailed review of the evidence.[1] The fourth general conclusion is that the tendency for imports to grow and exports to decline relative to one another was common to most trading areas except West Europe whose trade was unbalanced even in 1913. This point will be considered further later in the chapter in relation to the economic position of the country, to which it is fundamentally related, but the conclusion must be recorded here for it arises out of the structure of the foreign trade. The importance and magnitude of the task which faced the country on the conclusion of the war in remodelling the economy by restricting imports and stimulating exports, become inevitable as a result of war-time changes in the balance of payments, can be the more readily realized in the light of these trends of the inter-war years.

Table CXVI has been constructed to show the extent to which the balance of imports and exports has changed year by year since 1945. The war years have been omitted as irrelevant to the argument but the three immediately pre-war years have been added for comparison. The values are those actually returned and they have not been corrected for changes in price levels: they display changes in balance of trade, but not changes in level of physical volume as compared with pre-war years. Percentages of the total trade for each year of each class of retained imports and of exports of British produce and manufacture have been added to the table so that changes in balance can be deciphered the more readily. It is clear that imports have been reduced and that exports have been increased. Reduction of imports has been of foods and manufactures, that is, of consumption goods, and not of raw materials for industry, many of which in a more fabricated form enter into the export trade. Growth of exports has been of manufactures, there being an actual reduction in export of raw materials. These changes are consistent with increased industrial production at home and an increased proportion of such production exported. Increased industrial production has given rise to increased import of raw materials, and semi-products, increased export and decreased import of finished manufactures. Decline in import of food has been made possible by a growth in the agricultural output and by the continuance of food rationing. It can be said that the redirection of foreign trade up to 1950 has achieved

[1] J. H. Richardson, *British Economic Foreign Policy* (1936), pp. 147–55.

TABLE CXVI

Foreign Trade of the United Kingdom, 1937–50

	1937	1938	1939	1946	1947	1948	1949	1950
Value in £ million.								
Retained imports								
Class I	418	418	388	624	798	873	959	1,009
Class II	278	218	216	362	518	581	736	941
Class III	250	216	229	237	391	475	499	551
Total	953	858	839	1,251	1,728	2,014	2,216	2,518
Exports of British produce and manufacture								
Class I	39	36	36	64	65	94	98	135
Class II	65	57	54	33	34	68	82	105
Class III	405	365	338	789	999	1,377	1,560	1,882
Total	521	471	440	915	1,137	1,583	1,786	2,170
Percentages of Total Trade:								
Retained imports								
Class I	28·4	31 4	30·3	28·8	27·8	24·3	21·5	21·5
Class II	18 9	16·4	16·9	16·7	18·1	17·8	18·4	20·1
Class III	17·0	16·2	17·9	11·0	13·6	13·2	12·5	11·7
Total	64·6	64·6	65·6	57·8	60·3	56·0	55·4	53·7
Exports of British produce and manufacture								
Class I	2·6	2·7	2·8	2·9	2·3	2·6	2·4	2·9
Class II	4·4	4·3	4·3	1·5	1·2	1·9	2·0	2·2
Class III	27·5	27·5	26·4	36·4	34·9	38·3	39·0	40·1
Total	35·4	35·4	34·4	42·2	39·7	44·0	44·6	46·3

The definition of classes I, II and III is identical with that in Table CX.

some considerable measure of success, though it has not been obtained without cost.

II

THE STRUCTURE OF PORT TRADE

This is the general picture of British overseas trade. Each port presents a particular variant, if it be a general port, or a particular sector, if it be a specialized port, of this general theme. The commodity structure of the trade of each port is determined very largely by the resources and requirements of the areas with which it trades. A brief indication of the commodity structure of the trade of the major British ports will now be attempted. I will deal first, as in the analysis of the shipping traffic, with the large general ports. The structure analysed will be that of 1937 and 1948. The detailed commodity analysis for ports is being issued by the Customs and Excise Department only at three-yearly intervals. The most recent is that for 1948, published in 1950.

London had a large excess of imports over exports, and this excess of imports was proportionately greater than in the total trade of the United Kingdom. In 1937 London handled two-fifths of the

retained imports, but little more than one-quarter of the exports of British origin, though London had a large share of re-exports. In 1948 London handled a third of the imports but under a third of the exports. Both absolutely and relatively, therefore, London was primarily an importing port, though the lack of balance is less pronounced than formerly. Compared with total British trade, London imported more foods and manufactures and exported fewer raw materials and manufactures. The hinterland which London serves is thus less of an area where exports originate, whether these be raw materials or finished manufactures, and more of an area where goods are imported for direct consumption, whether these be foods or finished manufactures of foreign origin. From the point of view of the balance of the visible trade, that passing through the Port of London aggravated the lack of balance present in the total trade of the United Kingdom. Against this must be set the considerable contribution of London to invisible exports, notably commissions earned in the City of London and interest on capital invested abroad subscribed by the residents of London.

The commodities involved in London's trade exhibited a certain degree of specialization which reflected the character of the port and of its hinterland. London imported some raw materials, such as wood and timber, in about the same proportion to the country's total trade as the proportion of the population of the hinterland to the country's total population. It may be presumed that these were designed for regional consumption. Of other raw materials, such as metal ores and raw cotton, London had only a minute share of the country's total import, but of still others, such as wool and skins and rubber, London had the larger share in 1937. Some of these differences were due to the location of particular commodity markets, but these are subject to change. In 1948 Liverpool in fact imported more raw wool, hides and rubber than did London. Where the use of a particular raw material is concentrated into a single industrial region the commodity market tends to be located within that region,[1] but where the use is dispersed among many localities the commodity market tends to be set up at the main importing port. These generalizations apply only to the lighter commodities, and the heavier commodities, such as iron ore or timber, must be imported close to the point of consumption in any case. The port handled in 1937 46 per cent of the total imports of manufactures into the United Kingdom,[2] but London does not specialize in the import of any one group of manufactures more than in another. The very large proportion of the total imports of finished manufactures which pass through the Port of London is bound up with the continental source of the greater part of these manufactured imports. London faces the Continent

[1] Wool is an exception, but the pattern of shipping services and perhaps historical inheritance are responsible.

[2] It was 35 per cent in 1948.

and handles a large share of the traffic with it, except in coal. In exports of finished manufactures through the Port of London there was as marked a specialization as in the import of raw materials. The staple exports of nineteenth-century industrialism were represented to only a limited extent. London handled only a small fraction of the exports of manufactured textiles, manufactured iron and steel, ships, locomotives, and machinery. But the products of the newer industries were represented to a very much larger extent. In 1937 London exported half of the aircraft (including aircraft parts), over half the road vehicles, three-fifths of the paper and cardboard, and three-fifths of the electrical apparatus. The newer industries have a different geographical distribution from the old, and they have developed to a substantial extent within the range of the hinterland of the Port of London. In so far as the balance of the industrial structure of Britain is changing and in so far as the relative balance of industrial distribution as between the coalfields and the non-coalfield areas is changing too (although the distributional change was arrested and even reversed during the late war), the relative importance of exports of manufactures in the commodity structure of London's overseas trade may be expected to increase. The percentage of the total exports of British produce and manufacture which passed through the Port of London did, in fact, increase from 18·9 per cent in 1913 to 27·0 per cent in 1937, and 30·5 per cent in 1948.

Liverpool, the second general port of the country, had a better balanced trade.[1] Exports of British origin were valued in 1913 at £170 million and retained imports at £150 million; in 1937 at £155 and £182 and in 1948 at £533 and £533 million respectively. During the inter-war period imports had risen and exports had fallen relative to one another. Nevertheless, even in 1937 Liverpool continued to handle a greater export trade (excluding re-exports) than London. The commodity structure was also very different. As a percentage of total trade (retained imports plus exports of British produce and manufacture) Liverpool imported less food and fewer finished manufactures of foreign origin, but imported more raw material and exported more finished manufactures of British origin. Its trade is thus dominated much more than is that of London by the needs and output of British industry. The industry of its hinterland, moreover, has been bound up much more than that of London with overseas trade. This much can be inferred from the trade returns. But the contrast between Liverpool and London was becoming less sharply drawn, for, while the percentage of total exports of British origin which passed through London increased

[1] During the late war, Liverpool became the first port of the country: the change was due to the dominating position of the trans-Atlantic trade and to obvious reasons of strategy.

from 18·9 per cent in 1913 to 30·5 per cent in 1948, the percentage which passed through Liverpool increased only slightly from 32·8 per cent in 1913 to 33·7 per cent in 1948. Like London, Liverpool specialized on the import of certain classes of raw materials. It imported little iron ore, but a large share of the non-ferrous ores (chiefly tin); little flax and hemp, but most of the raw cotton and much of the raw wool; little paper-making material, but much of the hides and rubber. The imports which are stressed form the raw materials of the industries of the hinterland or of Merseyside itself. The exports of finished manufactures included textiles (especially cotton), pottery, glass, manufactured metals, machinery. The bulk of these exports were derived more from the industrial hinterland of the port than from the industries of the port itself. The port industries consist rather of the processing and manufacture of imported raw materials for the home market, although some Merseyside industries do export a fraction of their output.

London and Liverpool are the major ports of Great Britain, handling between them in 1937 and 1948 three-fifths of the total trade of the United Kingdom. Other ports have a much smaller bulk of trade, and they have frequently, though not invariably, a more specialized trade. The dominance of London and Liverpool is, up to a point, a dominance of trade partners rather than of trade rivals. Each handles a different kind of traffic in relative balance, each stresses trade with a different set of world regions, and each has its own hinterland within Britain. There is competition between them where their hinterlands are adjacent: the factors in this competition are relative port charges, relative costs of rail or road haulage between port and inland destination, relative sailing distances between port and overseas, relative frequency of liner services if the commodity be a liner cargo, relative level of tramp rates if the commodity be a tramp cargo, the existence or absence of a commodity market in the port. The pattern of competition is thus a very complex one and it affects unequally different commodities, different parts of the hinterland, and different overseas trading areas.

Hull and Manchester, both ports in the North of England and with hinterlands overlapping that of Liverpool, present some features in common. They were both primarily importing ports and thus presented a contrast with the better balanced trade of Liverpool. The trade of Manchester and Hull displayed a very similar proportionate relationship between imports and exports as the trade of London in 1937, but, although exports had increased from Hull and Manchester by 1948, they had not increased in the same proportions as they had for London. The contrast with Liverpool had not been so acute in 1913, although exports even in that year of active export trade were well below imports at these two ports. The relatively small volume of exports from Manchester and Hull, as compared with

Liverpool, is bound up with the less frequent liner services at these two ports. Finished manufactures, which provide the bulk of the exports, are primarily liner cargoes. Liner services equally varied in destination and equally frequent in time could not be economically provided for all three ports: Hull is on the opposite side of the country and Manchester is at the inland terminus of a waterway which passes Liverpool on both inwards and outwards journeys. The import trade is differently constructed. Many imports are tramp cargoes which are consigned, unlike liner cargoes, to a single destination. Single tramps can readily unload at Hull or at Manchester and the absence of liner services is not the same deterrent to the development of an import trade as it is to the development of an export of finished manufactures. Like Liverpool, Hull and Manchester[1] have developed port industries based on imported materials brought in by tramps or tankers. These raw material imports are very specialized. At Hull raw wool, oil-seeds, and timber together constituted 90 per cent in 1937 and 82 per cent in 1948 of the total raw material imports. The raw wool is for the woollen and worsted industries of the West Riding, the oil-seeds are for the port industries of Hull itself, and the timber is for the use of its regional hinterland. At Manchester raw cotton constituted 62·5 per cent in 1937 of the total imports of raw materials but it had fallen to under 50 per cent by 1948 owing to lesser activity in cotton manufacture. The raw material imports thus contribute directly in each case to the needs of the industrial regions which each port serves and to the industries of the port area proper. In the export of finished manufactures textile goods constituted the largest single group at Hull and Manchester, as at Liverpool; but, although they dominated the restricted export trade, they constituted a smaller proportion of the total trade of the port. The export of textile goods manufactured within Britain as a percentage of the total trade (retained imports plus exports of British origin) was 16·8 per cent in 1937 and 14·8 per cent in 1948 at Liverpool, but less at Hull and Manchester. Of the three, Manchester is the only one with local textile mills, and it is, moreover, the organizing centre of textile exports; but the export of textile manufactures enters into its trade to a lesser extent than it does into the trade of Liverpool. The export of iron and steel manufactures and of machinery displays the same difference between Liverpool, on the one hand, and Hull and Manchester, on the other, to an even more marked degree. Textiles and metal goods are the staples of the industrial districts of Lancashire and Yorkshire, which form the most important part of the hinterland of these three ports. All angles of approach thus converge to display Liverpool as the chief overseas *outlet* of industrial Lancashire and Yorkshire.

[1] The Port of Manchester includes the banks of the Manchester Ship Canal to its outfall at Eastham as well as the terminal docks at Manchester–Salford.

Bristol is the chief port of the south-western sector of England, as London is of the south-eastern, Hull of the north-eastern, and Liverpool and Manchester together of the north-western sectors. But it is now a more specialized port than any of these. Exports of British origin constituted only 4 per cent of imports and exports combined in 1937, and even in 1913 the percentage had been only 18. Bristol is the outlet of the West Country, which has few export industries, and it would seem that the export business from the West Midlands goes mainly through the large ports of London and Liverpool. A small export of manufactures implies limited liner services and limited liner services result in still less export. There is an ultimate cumulative effect and a limited export of manufactures thus tends to be eroded away. Even the import trade of Bristol was highly specialized. There was only a restricted import of commodities classified in the raw materials group, and this served strictly local requirements. The import of manufactures consisted primarily of two single items—refined petroleum and unwrought copper. Bristol has long worked non-ferrous metals. The chief specialism of the port was the import of foods and of unmanufactured tobacco. The unmanufactured tobacco, like the unwrought copper, is a raw material for a local Bristol industry. The food import comprised raw cocoa and wheat, which receive industrial treatment, dairy produce, fresh fruit, and grains other than wheat, which receive little or no industrial treatment. Apart from the import of foods, which are distributed over the entire hinterland of the port, the greater part of the imports is for the use of industries in the local Bristol region. The products of these industries, notably tobacco and chocolate, are then distributed over the whole country.

Southampton had a shipping traffic out of all proportion to the commodity trade which it handled. It was the third port in quantity of tonnage, but the sixth in value of trade. Much of the tonnage arrived or departed in ballast or set down or picked up very little cargo. Imports and exports approximately balanced, exports being slightly the greater. It presented some similarities with Liverpool in the percentage contribution to the total trade of imports of food and of exports of manufactures, but imports of raw materials constituted a lower and imports of manufactures a higher proportion than at Liverpool. There was also a very substantial parcels traffic—Class V of the classification of the *Annual Statement of Trade*. The exports of finished manufactures of British origin comprised the lighter rather than the heavier commodities, for Southampton is far removed from the main industrial centres of the country. Textiles, machinery, and vehicles, were more prominent than iron and steel, and, judging from a comparison of quantities and values, it would appear to be the more valuable items within each group which passed

through Southampton. It is significant that the export of apparel was a very much more important item in the commodity structure of the export trade of Southampton than in the export trade of the United Kingdom as a whole.

Glasgow is a general port operating on a smaller scale than Liverpool, but presenting some analogous features. Its import of food and its export of finished manufactures were of the same order of magnitude when expressed as a percentage of the total trade of the port, but the import of raw materials was less and the import of manufactures greater, and there was, in addition, an export in Class I. These differences, however, are more apparent than real. The export in Class I was an export of spirits, themselves manufactured. The classification adopted in the *Annual Statement of Trade* places pig iron with manufactures, but it is more properly a raw material for the steel-makers of the West of Scotland. After refined petroleum, pig iron constituted the largest single import of manufactures in 1937. In Glasgow's trade, exports exceeded imports, although the excess was by no means as pronounced in 1937 as it had been in 1913, when exports were about twice as great as imports when measured in values. As the outlet of one of the staple manufacturing districts of nineteenth-century Britain, Glasgow is appropriately more of an exporting than of an importing port. Even here, as at Liverpool, imports had risen and exports had fallen relative to one another during the inter-war period, but exports have increased again during the post-war years at about the same rate as at Liverpool or Manchester though at a lesser rate than at London. The old industrial districts were already intimately linked with export and it was the new industrial districts, trading through London, hitherto concerned largely with the home trade, which could provide a greater percentage expansion of export.

The specialist ports present a different pattern of trade. I will consider first the coal-exporting ports. The coal-exporting ports included in Table CXVII—there are many smaller ones in addition—are in South Wales, on the North-east Coast, on the Humber, and on the Firth of Forth. The South Wales ports include Cardiff, Swansea, and Newport. The trade of Cardiff was in 1937 rather more general and less tied up exclusively with the immediate locality than the trade of Newport or of Swansea. Cardiff had a substantial import of food, chiefly grain. The trade of Swansea comprised only a restricted range of items. There was an import of pit-props, of iron ore, of steel semi-products, such as tinplate bars, of non-ferrous ores, and of non-ferrous semi-products. There was an export of coal, of manufactured fuel, and of finished steel and non-ferrous manufactures. The whole of this trade was bound up directly with the industries of the immediate district. The trade of Newport was equally specialized. There was an import of pit-props, of iron ore,

TABLE CXVII

Commodity Structure of Overseas Trade at Certain British Ports

As per cent of total trade

	Retained imports						Exports of British produce and manufacture					
	1937			1948			1937			1948		
	I	II	III	I	II	III	I	II	III	I	II	III
London	36	14	22	29	13	15	3	1	22	4	—	37
Liverpool	22	25	7	19	22	8	2	2	41	2	1	47
Hull	26	28	16	31	19	15	1	6	23	1	4	27
Manchester	18	34	27	13	30	24	—	3	18	1	3	29
Southampton	21	8	16	14	14	15	5	—	42	2	—	45
Bristol	59	11	26	62	10	21	—	1	2	—	—	7
Glasgow	25	10	12	24	10	10	12	2	38	9	1	45
Leith	54	13	11	51	16	8	4	6	12	2	1	19
Tyne Ports	31	12	13	29	11	12	1	21	22	—	8	40
Middlesbrough	1	30	8	—	30	6	—	3	58	1	2	61
Goole	11	11	20	10	—	22	1	18	38	1	11	56
Grimsby	46	18	9	39	12	11	1	11	14	3	17	15
Cardiff	21	17	6	33	27	2	—	48	7	1	18	19
Swansea	2	19	14	3	31	16	—	15	50	—	7	43
Newport (Mon.)	1	8	27	2	8	18	—	27	37	—	12	57
Grangemouth	2	48	30	—	46	16	2	5	13	2	2	34
Harwich	40	2	45	34	2	19	1	1	8	4	3	33

Class I—food, drink, and tobacco.
Class II—raw materials and articles mainly unmanufactured.
Class III—articles wholly or mainly manufactured.
Total trade comprises retained imports plus exports of British produce and manufacture.

and of steel semi-products, such as blooms and billets. There was an export of coal, manufactured fuel, and finished iron and steel goods. Cardiff participated in this trade which was bound up with the industries of the locality, but it had, in addition, some general trade designed to meet regional rather than local needs. On the North-east Coast the Tyne ports had the more general trade, Middlesbrough, the Hartlepools, Sunderland, and Blyth, the more specialized trade. Blyth was little more than a coal wharf. Sunderland imported pit-props, iron ore, and steel semi-products; it exported coal, coke, and completed ships. Its trade comprised little else. The Hartlepools also imported pit-props, iron ore, and scrap, and exported coal, coke, and completed ships; but they had, in addition, a substantial import of sawn soft woods. Middlesbrough was not strictly a coal port at all: it is not on the coalfield and its position on the south bank of the Tees places it away from the channels of coal export. Its trade was tied very closely to the two industries of iron and steel and of chemicals; there was an import of iron ore and an export of iron and steel manufactures, of ships and manufactured chemicals. Of the trade of the Tyne ports, a smaller proportion was

bound up directly with coal, iron and steel and ships. There was also a large import of food (of butter, eggs, and bacon from Denmark, of fish from Norway, and of wheat from more distant parts of the world), a substantial import of furs and of sawn timber, an export of textiles, chemicals, and machinery. Some of this was the general trade of the country and not local trade at all. Though they exported coal, the Humber ports were general ports rather than specialized coal exporters, and their coal export had come to be much less than formerly. They imported foods and timber and they exported a wide range of finished manufactures, though in small quantities. They are tied up with their Yorkshire and Lincolnshire hinterland with its iron and steel and textile manufacture. Raw wool and iron ore were imported, woollen and worsted pieces and finished iron and steel manufactures exported.

The packet stations, such as Dover, Folkestone, Holyhead, Fishguard, Weymouth, and Harwich, constitute a second type of specialized ports. They have a shuttle service backwards and forwards along a short sea route. The traffic in goods is usually scarcely commensurate with the shipping traffic, and in special cases it may be out of all proportion. Thus Dover had a light and Weymouth a heavy goods traffic in proportion to the quantities of shipping arriving and departing. The Dover traffic carries the passengers between Britain and the Continent, while Weymouth has the goods traffic with the Channel Islands. The trade of Harwich was primarily import and consisted of butter, eggs, and bacon, and a wide range of manufactures brought in from the nearby Continent. The largest single item in 1937 among the manufactures was artificial silk. Many of these imports were of Dutch origin and the greater part of the shipping arriving and departing was on the Harwich-Hoek van Holland run. The trade of Dover was also predominantly import. Its food imports were chiefly wines, its raw material imports chiefly skins, and its import of manufactures chiefly the lighter products of the Continent, such as clocks and watches, textiles and apparel. Exports from Dover comprised a wide range of manufactures, of which textiles and apparel were again the chief items. This trade, both import and export, was relatively light in proportion to value, and even the values were low in proportion to the quantity of shipping tonnage involved. The Holyhead trade was better balanced, a reflection of the better balance of the trade with Eire as a whole. An export of manufactures balanced an import of food and of live stock. The manufactures involved a wide range of commodities, providing a sample of British industrial production. No coal was exported, for this was the perquisite of the coalfield ports. The retained import of live stock, mainly dairy stock and horses, constituted in 1937 no less than 14 per cent of the entire trade and 31 per cent of the retained imports, and in 1948 17 and 51 per cent respectively.

III

THE BALANCE OF PAYMENTS

The visible trade so far considered does not constitute the whole of the British economic relations with the rest of the world. Earnings from shipping and insurance and income from overseas investments are also involved in the balance of payments. The examination of the balance of payments is an economist's problem and requires tools of economic analysis, but the economic position of Britain has geographical consequences and the understanding of the economic position requires some knowledge of the balance of payments.

The large deficit in the visible trade, that is, an excess of imports over exports, is no more necessarily an index of national bankruptcy than a large excess of exports over imports is necessarily an index of national prosperity. The visible trade is only one part of the total balance of payments. There must also be taken into account (*a*) the earnings of British shipping[1] in carrying the visible trade to and from Great Britain and between other countries of the world, (*b*) receipts from commissions and insurance and, a very important item, (*c*) the income derived from British investments abroad. The earnings from these services must be set against the adverse visible balance of trade. Those countries, such as the Argentine, with an excess of exports over imports, having, that is, precisely the opposite visible balance of trade to Britain, have to set against the favourable visible balance of trade interest or dividends on foreign capital invested in the country. There is nothing fixed about this income from 'invisible' items, and it varies especially with the state of trade, being high in times of boom and low in times of depression, as the table shows. In times of depression not only does the physical volume of trade diminish, but freight rates are low and shipping income suffers on both counts. In times of depression interest on foreign investments also contracts. At the same time, there is a tendency in times of depression for exports from Britain to contract seriously, while imports of food, though not of raw materials, are maintained. Table CIV, in the previous chapter, demonstrates this clearly. The credit or debit balance of Britain's balance of payments thus fluctuates violently between boom and depression. There were credit balances in the boom years of 1913 and 1929, though there was a small debit balance in 1937, partly because imports were particularly high in that year owing to the rearmament programme. There was a large adverse balance during the Great Depression culminating in 1931, but

[1] Earnings of British shipping entered in the table represent (*a*) total earnings of British ships carrying merchandise in the overseas trade between Britain and foreign countries (and between one foreign country and another) and in carrying passengers not normally resident in the United Kingdom, together with (*b*) the disbursements of foreign ships in British ports, less (*c*) the disbursements of British ships in foreign ports and less (*d*) fares paid by passengers normally resident in the United Kingdom to foreign ship-owners.

TABLE CXVIII

Britain's Balance of Payments on Current Account

(in £ million)

	1913	1929	1931	1933	1937	1938
Visible Trade:						
Net deficit	145	381	408	263	442	377
Invisible items:						
Net income	339	484	304	263	386	335
Shipping	94	130	80	65	130	100
Overseas investment	210	250	170	160	210	200
Others	35	104	54	38	46	35
Credit or debit balance	+194	+103	−104	—	−56	−55
	1938	**1946**	**1947**	**1948**	**1949**	**1950**
Net deficit in visible trade	302	176	425	207	153	153
Net income from invisible items	232	−172	−133	177	183	382
Credit or debit balance	−70	−348	−558	−30	+30	+229

From the annual returns in the *Board of Trade Journal* in the upper part of the table and in the lower part from Cmd. 7793, 8065 and 8195. The two series are constructed on different principles, as the two calculations for 1938 show.

by 1933 the adverse balance had disappeared, owing partly to the effects of the Import Act of 1932 in readjusting the visible balance of trade. But it is clear that the level of the credit balance was declining at successive trade cycle crests, being less in 1929 than in 1913, and being replaced by a debit balance in 1937. During the nineteenth century Britain was the source of most of the capital invested abroad, and it was the interest on this which was responsible for the large income from overseas investment. A large credit balance provided capital for fresh investment abroad or for investment at home. Of that invested abroad some repayments are always in progress, and in the years immediately prior to 1939 repayments actually exceeded British subscriptions to new overseas issues, though this had not been true of the 'twenties, nor even of the years of the Great Depression.[1] Investments abroad were declining. A greater proportion of the capital available, in fact, was being invested in home securities. The following table, abstracted from Colin Clark's *The Conditions of Economic Progress*, is very instructive. During the late war, particularly before the operation of Lend-Lease from the United States and Mutual Aid from Canada, a substantial proportion of these overseas investments were sold or repatriated and the income from those remaining has been greatly reduced. In 1946 and 1947 there was even a debit in respect of income from invisible items owing to the continuance of heavy spending on government account

[1] R. Kindersley, 'British Overseas Investments', annually in the *Economic Journal*. For 1928–30, British subscriptions to new issues on the London market were £332 million and repayments £118 million, and for 1931–4 £224 million and £184 million, but for 1935–8 £201 million and £288 million.

TABLE CXIX

Home and Foreign Investment, 1907–35

(in £ million)

	National Income	Net capital accumulation		
		Home Investment	Foreign Investment	Total
1907	1,940	110	138	248
1924	4,035	255	72	327
1935	4,530	305	20	325

From Colin Clark, *The Conditions of Economic Progress* (1940).

overseas. Britain has been compelled to reduce imports and expand exports and the debit balance in the visible trade has been greatly reduced. At the same time there has been some recovery in the income from the 'invisible' items. In 1949 payments on current account (including both visible trade and invisible items) once more balanced and in 1950 there was a very considerable credit balance. This was, however, much larger than was anticipated[1] and it is most unlikely that it will continue at that level. There has been in recent years a not unsubstantial capital investment overseas in the sterling area but against this must be set government borrowing from the dollar area and repayments such as that of Argentine railways in 1948, and it was not until 1949 that there was a net credit balance in respect of overseas investments.[2] New capital accumulation is in fact insufficient for the requirements of home investment.[3]

IV

THE BRITISH ECONOMY

The foregoing discussion both of the overseas trade and of the balance of payments is of contemporary conditions. But, in order to place these contemporary conditions in proper perspective, it is necessary to view them against long-term trends.

The elucidation of trends in economic activity is as intricate a statistical exercise as the elucidation of trends in rainfall: each have short-term fluctuations imposed on long-term and each display regional variations within Britain, not only in intensity but even in nature of trend. W. W. Rostow,[4] for example, sets forth some twenty-four short-term 'cycles' and some five 'trends' between 1790

[1] *Economic Survey for 1950* (Cmd. 7915) assumed £50 million as the probable surplus on current account for 1950. In the end it turned out to be £229 million.

[2] *United Kingdom Balance of Payments 1946–50.* (Cmd. 8065) that is, subtracting disinvestment from new investment.

[3] E. A. G. Robinson, British Economic Policy, 1945–50. *London and Cambridge Economic Service*, vol. xxviii, Bull. ii (1950).

[4] W. W. Rostow, *British Economy of the Nineteenth Century* (1949).

and 1914. The trade cycles with crests at 1913, 1929 and 1937 were short-term fluctuations in this sense, 1913 and 1929 belonging to major rather than minor cycles in Rostow's terminology.[1] But it is the long-term trends which it is now necessary to consider. In the last 75 years the following periods may be distinguished. From 1873 to 1898 was the period of the Great Depression, as it was known to contemporaries, a halt in the industrial and trade expansion of the country.[2] Prices fell, industrial output expanded but little, though it was changing in balance as between different branches of manufacture, and there was a decline in investment overseas. It was succeeded by a short period culminating in 1913, when prices rose, industrial output grew, unemployment contracted and investment overseas was renewed. Exports expanded more rapidly than imports, partly because the terms of trade[3] were unfavourable to the United Kingdom, and the debit balance of the visible trade fell. During the inter-war period, prices fell, industrial output expanded only slowly, though again it was changing in balance as between different branches of manufacture, and Britain had only limited resources to invest overseas.[4] Exports fell and imports expanded, for the terms of trade were favourable, and the debit balance of the visible trade increased. Superimposed on this secular trend was the Great Depression of the early 'thirties with positive decline in production and severe unemployment. In the contemporary period after the 1939–45 war, prices have risen, exports increased and imports declined, partly because the terms of trade are unfavourable[5] but also because of the manipulation of the economy, the debit balance of the visible trade has fallen and there is full employment. But at the same time there is only slow expansion of industrial output despite full employment and there is little investment overseas; while comparable with the period preceding 1914 in its visible trade, it is not comparable in these other conditions. It is thus clear that, despite the repetitive phenomena, the position to-day is in many respects more precarious than in the first decade of the century.

The relative importance of the home and export markets is of large geographical significance for these affect different sections of the economy unequally and display different regional patterns. The British economy was built up during the nineteenth century,

[1] The year 1937 had a relatively high percentage of unemployment for a period of boom and only restricted investment overseas.

[2] The trade of the Port of Liverpool displayed this extremely clearly. Within the phase there were crests in 1873, 1883, and 1890 of equal magnitude and troughs in between in 1879 and 1885–6.

[3] The terms of trade represent export prices divided by import prices: they are favourable when import prices are low relative to export, unfavourable when import prices are high relative to export.

[4] W. A. Lewis, *Economic Survey, 1919–1939* (1949).

[5] Terms of trade from 1913 to 1947 are given in *Hansard*, 22 June 1948. *Official Report. Parliamentary Debates*, 1947–8, vol. CCCCLII, p. 1135.

when Britain led the world in factory industry, on the basis not only of the home but also of the export market. Between 1860 and 1910 exports were 18–20 per cent of the national income and expanded roughly in proportion to the growth of the national income. In the period immediately preceding 1914 export was growing more rapidly than industrial output, but income from investments overseas was growing rapidly also at the same time. After the 1914–18 war, exports declined but the national income continued to grow and exports as a percentage of national income declined to 16½ per cent in 1929 and 10 per cent in 1937.[1] The proportion of export to total industrial production according to Census of Production data was 27 per cent in 1924, 22 per cent in 1930 and 17 per cent in 1935.[2] The national income, of course, comprises more than industrial production and these two sets of figures are not necessarily inconsistent. By the eve of the war, therefore, export trade was little more than half as important in the British economy as it had been in the second part of the nineteenth century. It was in part an absolute decline but it was much more a relative decline, relative to the growth of the home market.

This decline of the contribution of export to the British economy was of great significance. It was partly a function of the growing industrial development of the world. The index of world manufacturing industry (1913 = 100) rose to 139 in 1926–9 and to 185 in 1936–8 but the world trade in manufactures was 104 in 1926–9 and 92 in 1936–8.[3] Britain was responsible in 1872 for some two-thirds of world exports of finished manufactures, in 1913 for one-third, in 1929 and 1937 for one-fifth.[4] Countries which were formerly dependent on British manufactures produced many of these commodities themselves or imported them from an alternative supplier, able to make them more cheaply. Increasing world industrial output need not necessarily have this result for as industrialization becomes more complex there are, according to the theory of comparative costs,[5] more opportunities for industrial specialization and the exchange of the results of such specialization. No less than 35 per cent of world trade in manufactures is in fact between industrial countries. The decline in British exports during the inter-war period was severe because so many of her exports prior to 1914 had been of consumption goods such as cottons, that is, precisely those which new industrial countries have manufactured first.

[1] A. J. Brown. *Industrialization and Trade* (1943), pp. 59–60.

[2] H. Clay. 'Exports in British Industry after the War'. *Economic Journal*, vol. LII (1942). The method of calculation is in Chapter V of the *General Report* on the Fourth Census of Production.

[3] These index numbers are from the League of Nations report, *Industrialization and Foreign Trade*. Prof. W. A. Lewis has criticized the precise quantities, but the disparity between the two trends is unquestionable.

[4] A. J. Brown, *Applied Economics* (1947), pp. 204–5.

[5] For an exposition of the theory see Barrett Whale, *International Trade* (1932).

The decline in the contribution of export to the British economy was due further to the world-wide tendency, in which Britain shared from the 'thirties onwards, to diversify national economies and to limit international specialization of production. It has arisen out of the demand for security, both military in time of war and economic in time of depression, which is so much the psychological temper of the age. A condition of free trade, necessary for the full development of international specialization of production on the basis of comparative advantages of resources and of aptitudes, has been replaced by a condition of restricted trade, necessary for the diversification of each national economy and the insulation or protection of industry or agriculture, as the case might be, from the competition of other countries with greater comparative advantages. 'Thus,' Sir Henry Clay has written, 'the trend between the two wars was in the direction of a reorientation of industry away from exports. The readjustment forced on British industry by the spread of protection in its former markets took the form partly of adaptation to other markets and exports, but much more of adaptation to the needs of our expanding home market. This was a spontaneous adaptation, not at all the result of deliberate Government policy, which continued to attach primary importance to exports. Even after the revolution in fiscal policy in 1932 the Government was at least as anxious to assist the distressed export industries, on which the depressed areas depended, as to foster new industries by protection.' In place of exports to foreign markets of goods made in Britain the tendency between the wars in a wide range of industries was for British manufacturers to establish subsidiaries behind the tariff wall of the foreign country. This was a form of capital export and provided the manufacturer with income from overseas, but it did not provide British labour with employment and it contributed much less to the national income than if the goods had been made in Britain itself.

Since the 1939–45 war, with the increase of exports at a faster rate than the growth of the national income, the percentage of exports to national income has increased to 14 per cent in 1947, 17 per cent in 1948, 19 per cent in 1949 and 21 per cent in 1950.[1] The pre-1914 proportions have been restored. The composition of post-war exports of manufactures presents features which it is important to recognize. Textiles constitute a much smaller proportion and machinery and engineering products a much larger proportion than formerly: in 1913 textiles were 43 per cent and machinery and engineering products 15 per cent of exports of manufactures but in 1950 they were 20 per cent and 43 per cent respectively (see Table CXIII). This change in balance had been developing in the inter-war period but it has been accelerated during the contemporary

[1] Estimates of national income have been taken from the *Economic Surveys* and exports from the trade returns.

post-war period. As a shift from consumption to capital goods, it is a response to the progress of world industrialization. It is impossible to say to what extent this increase in the proportion of exports registers a permanent condition. It is unquestionably a response to the needs of the situation, but it has been achieved only by direction of production towards export and away from home consumption, direction which has been inevitable in order that solvency should be attained. The need for a high level of exports will continue so long as Britain continues to need a high level of imports of foods and raw materials and so long as only a small proportion of these can be paid for by earnings on overseas investment. Overseas investment has been considered previously. It is necessary now to inquire into the extent to which British agriculture and industry can in fact supply home requirements.

The extent to which British agriculture and industry supply home requirements can be stated for finished consumption goods with some tolerable precision from the *Reports* on the Census of Production and from the *Agricultural Output*. It must be remembered, however, that, in the making of these finished consumption goods, imports have played a very large part in the form of feeding-stuffs for stock, fertilizers for crops, and raw materials for industry. Particulars drawn from the *General Report* on the Fourth Census of Production are set out in Table CXX. Britain, thus produced in 1924 and 1930 some three-quarters or four-fifths, according to whether the value of Customs and Excise Duties be included or excluded, of the finished goods ready for consumption. A similar calculation has not yet been published to cover the whole of British production from subsequent Censuses of Production.

This is the general position. It is possible to fill in the general picture for the inter-war period by reference to the *Reports* on the Censuses of Production on individual industries. They display the very large share of the home market for finished goods that is supplied by British factories. Only in respect of a few commodities in a long list is the British market supplied mainly from abroad. Out of 179 separate items in 1935, 40 supplied 99–100 per cent of the British market and 116 supplied 90 per cent and over, while only 19 supplied less than 50 per cent.[1] It is otherwise, of course, with raw materials and semi-products, which are imported extensively from abroad. And it was otherwise too with agricultural products, less than half of the total agricultural products by value consumed within Britain being the product of British fields and farms. There has been some increase in the agricultural output since that time, yields of crops per acre being higher, but the extent of increase is insufficient to make it possible for the country to become agriculturally self-sufficient. It has been estimated that home production provided 31 per cent of the

[1] These refer to items in Parts I–III of the *Final Report* on the 1935 Census of Production.

TABLE CXX

Output of Great Britain in Relation to Consumption

	1924	1930
	£ million	£ million
Agriculture	315	269½
Fishing	20	19
Forestry	2	1½
Industry	2,387	2,167
Total output	2,724	2,457
Exports	743	535
Output retained in Great Britain	1,981	1,922
Imports of goods ready for consumption	444	449
Customs and Excise duties	227	235
Available for distribution within Great Britain	2,652	2,606
	Per cent	Per cent
Proportion of output retained in Great Britain	72·7	78·2
Share of home market held by British goods:		
Including value of Customs and Excise duties	74·7	73·7
Excluding value of Customs and Excise duties	81·7	81·1

From *General Report* on the Fourth Census of Production.

Output of industry excludes duplication owing to fertilizers, feeding-stuffs, etc., manufactured in Great Britain and consumed by British agriculture, etc., and it excludes products of British agriculture, etc., which are used by British industry.

Exports are of values at point of production; that is, deducting transport and handling charges between factory and stowage on board ship.

intake of calories before the war but 37 per cent in 1948–9, 45 per cent of the total protein before the war but 51 per cent in 1948–9, the increase being chiefly in vegetable protein. However efficient British agriculture might become, it would not be possible therefore for it to provide all the foodstuffs needed unless population were to be maintained at a very low level of nutrition.[1] Industrial production of certain commodities has advanced beyond the capacity of Britain to supply such industries with their raw material, and some industries, moreover, are dependent on raw materials which are entirely absent from Britain for geological or climatic reasons. Britain cannot become wholly self-sufficient and a tariff policy or an employment policy which aimed at or assumed complete self-sufficiency would be doomed to failure. Britain could not, even if she wished, isolate herself wholly from the rest of the world.

These relative fluctuations of production for export and production for home consumption have resulted in substantial changes in the balance of industrial development within the country. I will consider first the changes as they had developed by 1939. The

[1] For a discussion of the whole problem see A. D. Hall, *Agriculture after the War* (1920) and E. J. Russell (ed.) *Agriculture To-day and To-morrow* (1945).

economic prosperity of regions largely dependent on export had declined, in some cases positively, but in all cases relatively, while the economic prosperity of regions catering mainly for the home market had increased. The regions dependent on export had a large proportion unemployed, the regions dependent on the home market had only a small percentage of unemployment. Some of the regions dependent on export suffered a positive loss of population, while those dependent on the home market had a positive gain of population. The relative decline of the North-east Coast and of South Wales and the growth of Greater London were the most striking examples. It has been shown that the growth of Greater London has been due not so much to any inherent genius of the place as to the large part played in its industrial structure by those industries supplying the home market. These industries have played a lesser part in the industrial structure of South Wales or of the North-east Coast and their growth, which has occurred here as well as in Greater London, had been insufficient during the inter-war years to compensate for the decline in employment among their staple trades.[1] Those regions dependent largely on export had been the better able to maintain their position if they were makers of vehicles and machines. Employment in the Manchester district, with a wide range of engineering industries, had been better maintained than employment in the specialist cotton towns.[2] Each of these trends has had cumulative effects. Prosperity begets prosperity and depression begets depression. The depressed areas acquired some new industries during the late war, and are acquiring others under their present status as Development Areas, as a result of deliberate Government policy. These will limit depression due to the decline of their staple trades.[3]

Tables CXXI–CXXII set out data derived from the returns of the Ministry of Labour. The general statements of the preceding paragraph can now be examined a little more precisely. It will be

[1] 'In the main, and ignoring that large group of activities of a financial, social and administrative character associated with a capital city, the relative growth of the London and Home Counties area is due not to an increase in London industries at a higher rate than that of similar industries in Great Britain as a whole but to the fact that (*a*) the area is composed almost entirely of expanding industries (and largely of those industries that were growing more rapidly than population in the country as a whole) and (*b*) such industries form a much smaller proportion of the total in other areas in which the contracting industries form a larger, or much larger, proportion of the total. The apparent attraction of London thus means little more than the normal growth of a prosperous area which is able to foster its prosperity by immigration' (*Report* of the Barlow Commission, Appendix II on the Location of Industry by Professor J. H. Jones).

[2] *Readjustment in Lancashire* (1936). In 1937 Manchester had an average monthly unemployment of 9·7 per cent, Blackburn of 21·5 per cent.

[3] See Distribution of Industry Act, and White Paper on *Employment Policy* (1944). For the working out of the policy on its distributional side, see *Industrial Opportunities in the Development Areas* (1946), and *The Development Areas To-day* (1947), both reprints from the *Board of Trade Journal*.

TABLE CXXI

Regional Changes in Employment, 1923–37.

	Nos. of insured employed				Percentage unemployed	
	1923 (thous.)	1937 (thous.)	Per cent + or —. absolute	relative to G.B.	1929	1937
London	1,856	2,695	+45	+21	4·3	5·6
South-eastern	577	920	+59	+35	3·9	5·1
South-western	669	934	+40	+16	6·8	6·4
Midlands	1,468	1,944	+32	+ 8	9·1	6·5
North-eastern	1,101	1,256	+14	—10	11·5	12·0
North-western	1,653	1,851	+12	—12	12·6	12·8
Northern	644	654	+ 2	—22	14·5	16·7
Scotland	1,078	1,203	+12	—12	11·0	13·9
Wales	564	484	—14	—38	18·2	20·7
Great Britain	9,610	11,941	+24	—	9·6	9·8

Calculated from returns in *Ministry of Labour Gazette*, vol. XLV (1937).

The Ministry of Labour Divisions are those as defined in June 1937. The returns in the table exclude agricultural workers. The number of insured employed is arrived at by subtracting the numbers unemployed in June from the number insured according to the July count.

observed that all regions, except Wales, had an increase in numbers of insured employed between 1923 and 1937. The two years are not strictly comparable, for they do not each occupy the same point in the trade-cycle, but a comparison of conditions in the two years nevertheless permits the recognition of trends which developed during the inter-war period. But while all areas except Wales had an increase in numbers of insured employed between the two dates, it is possible to classify them as in col. 4 of Table CXXI according to whether their percentage increase was greater or less than that of Great Britain as a whole. Thus, while London, the South-east, the South-west and the Midlands had a percentage increase greater than the average, the North-east (mainly Yorkshire), the North-west, the North (mainly North-east Coast), and Scotland had a percentage increase less than the average. The North of England, Scotland and Wales, include almost all those industrial regions which are mainly dependent on export. The increase that did occur in insured employed even in these regions was due to the growth of the number employed in services, and to the growth of employment in industries other than those dependent on export. The larger percentages unemployed in these same districts, even in boom years when the volume of exports is higher than in depression years, is shown in cols. 5 and 6 of Table CXXI. They suffered even in good years.

TABLE CXXII

Classification of Industries according to Trend of Employment, 1923–1937

A. Percentage Insured

	1923				1937			
	Local	Expanding Basic	Declining Basic	Others	Local	Expanding Basic	Declining Basic	Others
London and Home Counties . .	35	21	1	43	38	25	1	36
Midlands . .	16	26	12	46	20	30	7	42
West Riding, Nottingham and Derby	14	9	43	33	21	14	32	33
Mid Scotland . .	25	10	24	40	33	13	15	39
Lancashire . .	19	9	36	36	26	16	24	35
Northumberland, Durham . .	16	6	49	28	25	9	33	32
Glamorgan, Monmouth .	13	4	59	24	22	6	41	31
Great Britain . .	24	14	23	39	30	19	14	37

B. Percentage Change

	Local	Basic		Others	All industries
		Expanding	Declining		
London and Home Counties .	+54	+69	− 4	+21	+43
Midlands	+67	+51	−28	+17	+28
West Riding, Nottingham, Derby	+69	+75	−15	+15	+15
Mid Scotland	+43	+46	−31	+ 5	+10
Lancashire	+47	+86	−28	+ 2	+ 8
Northumberland, Durham .	+63	+63	−29	+18	+ 5
Glamorgan, Monmouth . .	+59	+49	−34	+26	− 4
Great Britain .	+57	+66	−25	+14	+22

For the definition of these groups see footnote.

From Appendix II, *Report*, Barlow Commission.

Table CXXII gives the classification of industries attempted by the Ministry of Labour on the evidence of trend of employment and adopted by Prof. J. H. Jones and G. D. A. MacDougall.[1] The table

[1] The 'local' industries selected by Professor J. H. Jones and G. D. A. MacDougall for the purposes of this table include the distributive trades, building trades, gas, water and electricity supply, road transport, laundries, and bread and biscuit manufacture. All these, except biscuits, are distributed widely in rough proportion to population. The rapidly expanding 'basic' industries selected for the purpose include a miscellaneous group of trades, such as motor vehicle assembly, many forms of engineering, artificial silk, etc. The term 'basic' is that of Professor

shows clearly that the local and expanding basic industries of the classification were everywhere growing at rates somewhat comparable in all areas and not at lower rates in the export districts. It is equally clear that the declining basic industries were declining everywhere and at somewhat comparable rates.

TABLE CXXIII

Regional Distribution of Employment, 1939–51

	Percentage of total insured employed in Great Britain								Percentage unemployed	
	Males				Females				June 1951	
	July 1939	July 1945	July 1948	June 1951	July 1939	July 1945	July 1948	June 1951	Male	Female
London & South-eastern	23·5	19·8	24·0	24·3	27·5	23·8	26·9	26·0	0·6	0·6
Eastern	5·3	5·2	5·3	5·0	4·0	4·8	5·0	4·7	0·6	0·7
Southern	4·8	4·7	4·8	5·0	3·2	4·5	4·4	4·5	0·6	1·1
South-western	5·4	5·4	5·5	5·2	3·9	4·8	5·0	5·1	0·8	1·0
Midland	9·9	10·3	9·7	10·1	10·1	10·1	9·8	9·7	0·3	0·4
North Midland	7·0	7·4	7·0	6·6	7·0	6·7	6·5	7·4	0·3	0·3
E. & W. Ridings	9·1	9·4	8·8	8·4	9·7	9·0	8·6	8·9	0·7	0·6
North-western	13·3	14·0	13·4	13·3	17·9	16·5	15·5	15·1	1·0	1·0
Northern	6·5	7·4	6·4	6·6	3·9	5·3	4·8	5·1	1·7	2·0
Scotland	10·3	10·8	10·2	10·4	10·6	10·7	10·2	10·0	2·1	1·8
Wales	4·9	5·6	4·9	5·1	2·2	3·8	3·3	3·5	2·0	2·7
Total	100	100	100	100	100	100	100	100	0·9	0·9

During the late war some of the inter-war regional trends were reversed. London in particular lost a great number of its insured workers by evacuation and had of all regions the lowest percentage in 1945 as compared with 1939. All the industrial districts of the Midlands, of the North of England, of Scotland and of Wales gained relatively, for both strategic and economic reasons. By 1948 the temporary war-time changes in distribution of male employment as expressed regionally appear to have worked themselves out and the distribution of male employment in that year was essentially comparable to that of 1939. But further changes, though only of small magnitude, have developed since 1948, despite the relative *regional* immobility of labour due to the shortage of housing.[1] There have been since 1948 increases, firstly, in Greater London and in the

Jones, for the Ministry of Labour employ the term to refer to coal-mining, gas, water and electricity supply and transport. The rapidly declining 'basic' industries selected include coal-mining, cotton, woollen and worsted, iron and steel, shipbuilding and repairing (*Report* of the Barlow Commission, Appendix II).

[1] There is a high degree of mobility within a district. Labour moves very freely from firm to firm, but not from district to district.

Midlands, and, secondly, in the Northern, Scotland and Wales regions, the one being the site of a great deal of engineering and vehicle assembly and the other being the recipients of the benefits of development area policy. It has been shown that engineering production enters very largely into export, increasingly so since the war. The beneficiaries of the export drive include not only the old exporting districts which suffered so keenly from depression during the inter-war years but also the new industrial districts formerly bound up very largely with the home trade but now making for export as well. It is harmonious with this development that the Port of London has increased its exports during the post-war years to a greater extent than any other of the major ports of the country.

Production for an export or for a home market requires a different distribution of industry within Britain. A country largely dependent on foreign trade has to locate its industries in such a way as to permit maximum economy of production and transport with regard to the practice of foreign trade. Exporting industries within easy reach of large general ports can export more cheaply, other things being equal, than industries far removed from such large general ports which alone offer the liner services which the export of finished manufactures requires. The additional costs due to the transport of the finished article to the port for shipment abroad may not be large as a percentage of the price of the article to the consumer, but export business is frequently conducted on very small margins, and even minute differences may have their effects. Industries producing for the home market, on the other hand, are located, if they be mobile with regard to raw materials, rather by the existing internal distribution of industry and population which provide that home market. Such industries can be dispersed much more widely over the face of the country. The declared policy of the White Paper and of its instrument the development area was to diversify the industrial structure of the exporting districts, which have hitherto concentrated their attention on the output of a restricted range of commodities in large quantities for both home and export markets and not on a wide range of miscellaneous commodities for the home market alone. In effect, this implies a wider distribution over Britain of those industries catering for the home market. The White Paper policy of diversification and balance may be designed in part on economic grounds, for an industry catering for a local market saves some transport costs in distribution to the consumer, though these may be offset by other costs, and even by transport costs in bringing raw materials to that industry. But it was designed much more on social grounds, the elimination of the pockets of severe unemployment which had developed during the inter-war period.

A greater relative importance of the home market would have some effect on agriculture. It has been argued that British agriculture was sacrificed on the altar of British industry in the second phase of the Industrial Revolution after the Repeal of the Corn Laws. There is some truth in this, for British exports could be purchased abroad only if Britain imported goods from those same foreign countries, and the goods which these countries could send were mainly foods and raw materials which competed directly with the products of British agriculture. It is not wholly true, for Britain's demand for certain foods and for certain agricultural raw materials had far outgrown the capacity of Britain's fields to produce them. It would be more correct to say that the existence of this bulk import of agricultural products from abroad, especially after the steamship and the railway had reduced transport costs and after refrigeration had improved the condition of imported foods, reduced the price which British farmers could obtain for their output. The primary producers which have sent large quantities of foods and raw materials to Britain, however, are developing industry themselves, largely with the aid of protection. They seek to diminish their imports of manufactures, but they continue to seek to export primary commodities in the same quantities as previously. A primary producer undergoing industrialization thus, says Sir Henry Clay, 'interrupts the flow by which the rest of the world paid for its agricultural exports without interrupting these exports itself'. Prices for agricultural exports fell and were at a low level during the years immediately preceding 1939. These favourable terms of trade permitted Britain to maintain her agricultural imports on a scale which might not have been possible if prices had been higher. The British farmer will probably not in the future suffer so severely from low prices for his output, as primary producers abroad may have less to send to Britain because of their industrialization and because of some partial depletion of the resources of their virgin soils owing to continuous cropping and soil erosion. This is quite independent of the effects of protection for the British farmer. An improved economic status for British farming would appear to be likely. A more diversified economic structure among the primary producers is thus likely to lead to a more diversified economic structure in Britain. While regional specialization in one country during the nineteenth century begat regional specialization in other countries, regional diversity of production in one country during the twentieth century is likely to beget regional diversity in other countries. The improved economic status of British agriculture during the late war has been the result of stimulus which, though giving an economic incentive to the farmer, was due ultimately to strategic considerations. It may in the future have an improved status due to economic factors. But the branches of British agriculture which will be the most remunerative will not be the old staples

producing a relatively low-priced product such as corn, though corn-growing may not be unremunerative in an absolute sense and corn-growing will doubtless continue for many reasons, but those producing a relatively high-priced product such as milk, fruit, and garden vegetables. Unless corn-growing is encouraged by subsidy, direct or indirect, in order to give effect to strategic design or to a policy of keeping the land in good heart, it is likely to retreat once again to areas of unconvertible husbandry.

The volume of the export trade of Great Britain which, despite the importance of the home market, is absolutely essential to pay for imports of foods and raw materials to feed British population and British manufacture,[1] is dependent very largely on the degree of efficiency displayed by British industry. During the nineteenth century Britain was technically in advance of most parts of the world and an expanding export trade in manufactures developed. In the twentieth century there are not the same contrasts in technical efficiency and Britain's lead, where it has a lead, is not as substantial. By reason of a high standard of living Britain has a disadvantage because of high wage-rates, but these can be offset by technical efficiency and a high output per unit of labour employed, if these be substantially greater than that of her competitors in foreign markets. A high standard of living and high wages are an industrial disability only if efficiency be low, but it is clear that British industry can compete in world markets only if efficiency of plant, of management, and of labour be of a high order. This is by no means true of all industries and great efforts are necessary to improve competitive efficiency. The Working Parties set up by the Board of Trade were an attempt to assess the need for and the magnitude of such improvement.

This is a not inappropriate point at which to conclude this economic geography of Great Britain. The land of Britain offers resources for human use, but the precise employment made of these resources has varied from time to time with changes in human equipment and technique. Regions vary in physical resources and they vary in the efficiency by means of which these physical resources are utilized. Variations in efficiency are, up to a point, within human control. A low level of efficiency can dissipate even natural advantages, a high level of efficiency can make effective use of even mediocre material equipment. The economic geography of Great Britain is modelled not only by the physical resources of the land of Britain, but also by the knowledge and efficiency of its people.

[1] It would be entirely false and unrealistic to regard the export trade as merely the 'overspill' of the home trade, to use the phrase sometimes employed.

APPENDIX A

Agricultural Returns for Selected Counties, 1870 and 1913

		Norfolk	Essex	Wiltshire	Cornwall	Cheshire
Per cent of total area						
Arable . . .	1870	61·6	59·5	48·7	42·2	27·7
	1913	59·5	51·8	30·4	36·7	29·6
Permanent grass .	1870	15·9	15·4	34·8	14·2	44·0
	1913	22·0	29·2	51·6	33·9	52·3
Total cultivated .	1870	77·5	74·9	83·5	56·4	71·7
	1913	81·5	81·0	82·0	70·6	81·9
Rough grazings .	1913	3·3	0·6	5·1	8·2	1·9
Agric. unproductive	1913	15·2	18·4	12·9	21·2	16·2
Per cent of cultivated area						
Arable . . .	1870	79·6	79·4	58·3	75·1	38·6
	1913	73·0	64·0	30·7	52·0	36·3
Permanent grass .	1870	20·4	20·6	41·7	24·9	61·4
	1913	27·0	36·0	69·3	48·0	63·7
Per cent of arable						
Grains . . .	1870	51·8	53·3	47·7	40·7	45·3
	1913	50·1	50·5	47·6	38·0	41·4
Beans and peas .	1870	3·0	11·6	4·9	—	2·4
	1913	2·9	10·8	1·5	—	0·2
Roots and green	1870	24·0	16·0	25·4	16·2	18·2
crops . .	1913	24·0	16·2	24·5	11·9	20·2
Seed grasses . .	1870	20·3	12·7	18·2	36·0	32·8
	1913	20·4	13·9	20·9	47·8	36·4
Bare fallow . .	1870	0·7	6·3	2·0	7·1	1·2
	1913	0·8	5·5	4·8	1·4	0·4
Fruit, hops, etc. .	1913	1·8	3·1	0·7	0·9	1·4
Wheat . . .	1870	23·3	29·1	23·3	14·5	17·4
	1913	15·4	25·4	19·7	5·9	9·9
Barley . . .	1870	23·2	16·8	16·2	14·5	1·2
	1913	24·2	12·0	9·4	10·1	1·0
Oats . . .	1870	4·1	7·1	7·8	11·7	24·5
	1913	9·8	12·4	17·6	21·8	28·9
Beans . . .	1870	1·6	7·0	2·9	—	2·2
	1913	1·6	5·9	1·2	—	0·1
Potatoes . .	1870	0·8	1·9	1·0	2·3	12·0
	1913	2·0	2·5	1·0	1·5	12·4
Turnips and swedes	1870	17·2	4·5	16·2	8·7	4·6
	1913	13·4	2·5	12·3	4·0	4·7
Mangolds . .	1870	4·4	4·6	1·2	2·7	0·9
	1913	7·1	5·2	3·4	3·4	2·5
Green crops . .	1870	1·6	5·0	7·0	2·5	0·7
	1913	1·5	6·0	7·8	3·0	0·6
Per cent of total grass						
Hay . . .	1870	44·3	50·6	39·6	20·2	32·0
	1913	43·8	48·4	44·1	22·0	38·8
No. per 100 acres of total area						
Cows and heifers in	1870	2·0	2·1	6·0	5·6	12·9
milk and in calf .	1913	2·6	5·3	9·2	8·8	17·1
Other cattle . .	1870	2·5	2·1	1·2	4·8	2·1
over 2 years .	1913	3·4	1·6	1·3	4·9	2·0
Other cattle under	1870	2·4	1·9	2·4	6·1	5·9
2 years . .	1913	4·5	3·5	3·8	11·8	8·8
Sheep over 1 year .	1870	32·7	26·6	54·7	39·4	11·6
	1913	16·8	10·8	26·4	22·4	7·3
Sheep under 1 year	1870	22·3	11·9	34·8	16·4	6·7
	1913	13·9	8·1	19·1	18·3	5·1

		Leicester	Radnor	Pembroke	Westmorland	Haddington
Per cent of total area						
Arable	1870	35·0	19·9	30·0	12·0	47·2
	1913	18·4	12·5	22·9	7·4	52·4
Permanent grass	1870	54·2	33·6	39·2	34·7	8·0
	1913	70·8	41·5	55·2	41·8	12·9
Total cultivated	1870	89·2	53·5	69·2	46·7	55·2
	1913	89·2	54·0	78·1	49·2	65·3
Rough grazings	1913	0·1	42·3	10·9	39·9	22·9
Agric. unproductive	1913	10·7	3·7	11·0	10·9	11·8
Per cent of cultivated area						
Arable	1870	39·2	36·1	43·4	25·7	86·8
	1913	20·7	23·1	29·2	15·0	80·3
Permanent grass	1870	60·8	63·9	56·6	74·3	13·2
	1913	79·3	76·9	70·8	85·0	19·7
Per cent of arable						
Grains	1870	56·0	48·8	54·2	39·6	46·0
	1913	51·4	45·6	52·2	39·8	41·6
Beans and peas	1870	8·8	0·4	0·1	0·2	1·7
	1913	3·2	—	0·1	—	0·4
Roots and green crops	1870	15·1	17·0	10·5	20·1	27·5
	1913	17·7	16·7	13·4	21·6	27·3
Seed grasses	1870	15·0	30·1	31·1	38·3	24·0
	1913	21·3	36·3	33·4	38·1	29·7
Bare fallow	1870	5·0	3·8	4·0	1·7	0·7
	1913	5·6	1·3	0·8	0·2	0·3
Fruit, hops, etc.	1913	0·8	0·1	0·1	0·3	0·7
Wheat	1870	26·7	14·6	7·6	4·2	13·4
	1913	20·7	5·2	2·4	0·2	6·5
Barley	1870	17·5	10·0	23·6	6·0	15·8
	1913	10·9	9·5	19·4	1·4	17·3
Oats	1870	11·8	23·8	23·0	29·2	16·7
	1913	19·7	30·9	30·3	38·1	17·9
Beans	1870	5·3	—	—	0·2	1·4
	1913	2·2	—	—	—	0·2
Potatoes	1870	1·2	3·1	3·6	3·6	10·0
	1913	1·7	1·8	2·4	3·7	10·3
Turnips and swedes	1870	9·4	13·1	5·6	15·3	16·3
	1913	7·1	13·7	6·4	16·0	16·1
Mangolds	1870	2·1	0·1	1·0	0·4	0·1
	1913	7·0	0·6	1·8	1·5	0·2
Green crops	1870	2·4	0·7	0·3	0·8	1·1
	1913	1·9	0·6	2·8	0·4	0·7
Per cent of total grass						
Hay	1870	18·4	23·0	21·9	27·5	21·7
	1913	32·5	24·1	29·4	29·0	25·0
No. per 100 acres of total area						
Cows and heifers in milk and in calf	1870	6·4	3·5	7·4	4·6	1·1
	1913	8·2	3·4	7·7	5·1	1·2
Other cattle, over 2 years	1870	10·0	2·6	3·8	2·0	1·4
	1913	10·3	2·2	3·2	2·3	4·3
Other cattle, under 2 years	1870	6·8	4·5	7·2	5·1	1·3
	1913	9·1	5·4	12·0	7·4	2·4
Sheep, over 1 year	1870	56·6	75·3	14·1	43·9	32·0
	1913	30·6	62·6	21·0	47·6	41·7
Sheep, under 1 year	1870	32·1	29·3	11·4	24·4	18·2
	1913	21·7	30·2	16·5	32·6	32·6

Calculated from County Agricultural returns for 1870 and 1913. The 1913 returns are fuller than the 1870, and it is therefore possible, e.g. to calculate rough grazings as a percentage of the total area for 1913, but not for 1870. The item land agriculturally unproductive is a residual figure, being the percentage of the total

		Aberdeen	Selkirk	Ayr	Wigton	Caithness	Shetland
Per cent of total area							
Arable	1870	43·1	9·4	24·6	34·4	17·3	
	1913	46 8	8·8	20·1	35·5	19·1	4·0
Permanent grass	1870	2·4	3·4	15·0	7·6	4·6	
	1913	2·9	8·6	23·6	14·5	6·3	6·7
Total cultivated	1870	45 5	12·8	39 6	42·0	21·9	
	1913	49·7	17·4	43·7	50 0	25 4	10·7
Rough grazings	1913	13·0	79·4	45·4	34·6	48 0	88 9
Agric. unproductive	1913	37·3	3·2	10·9	15·4	26·6	0·4
Per cent of cultivated area							
Arable	1870	94·7	73·3	62·1	82·0	78·9	34·4
	1913	94·2	50·7	46·0	71 0	75·1	37·4
Permanent grass	1870	5·3	26·7	37·9	18·0	21·1	65·6
	1913	5·8	49·3	54·0	29·0	24·9	62 6
Per cent of arable							
Grains	1870	38·8	31·6	33·7	35 6	43·5	66·4
	1913	35·2	32·3	30·2	28·1	38·6	53·2
Beans and peas	1870	0·1	—	0·8	0·3	—	—
	1913	0·1	0·1	0·5	0·1	—	—
Roots and green crops	1870	19·2	19·0	10·7	17·4	20 0	19 9
	1913	16 3	19·3	12·2	14·5	17·0	29·4
Seed grasses	1870	41·7	48·9	54 3	45·9	34·9	2·5
	1913	48 2	48·2	56 6	57 1	44 1	13·2
Bare fallow	1870	0·2	0·3	0·4	0·8	1·5	11·1
	1913	0·1	—	0·2	0·2	0 3	4·2
Fruit, hops, etc.	1913	0·1	0·1	0·3	—	—	—
Wheat	1870	0·1	0·4	3·8	3·7	—	—
	1913	—	0 2	0·6	0·1	—	—
Barley	1870	3·3	4·3	0·8	1·4	2·2	13·6
	1913	3·8	2·5	0·5	0·5	1·0	5·6
Oats	1870	35·2	26·7	28·9	30·3	41·3	52·9
	1913	31·4	29·6	29·9	27·6	37·6	47 6
Beans	1870	—	—	0·8	0·3	—	—
	1913	—	—	0·5	0·1	—	—
Potatoes	1870	1·5	1·6	4·9	2·7	3·1	16·7
	1913	1·2	1·3	6·3	1·1	1·8	17·9
Turnips and swedes	1870	17·4	16·3	5·2	14·2	16·3	2·4
	1913	14·6	16 6	4·8	12·8	14·8	7·1
Mangolds	1870	—	—	0·2	0·2	—	—
	1913	—	—	0·3	0·3	—	—
Green crops	1870	0·3	1·1	0·4	0·3	0 6	0·8
	1913	0·5	1·4	0·8	0·3	0·4	4·4
Per cent of total grass							
Hay	1870	14·3	10·9	28·9	12·5	19·6	3·7
	1913	16·1	14·3	20·7	8·9	16·6	9·6
No. per 100 acres of total area							
Cows and heifers in milk and in calf	1870	3·4	0·5	5·9	5·3	1 6	
	1913	3·4	0·7	7·6	8·6	1·7	1·9
Other cattle, over 2 years	1870	3 1	0·4	1·8	2·0	0·8	
	1913	4·0	0·3	1·9	3·4	0·6	0·6
Other cattle, under 2 years	1870	5 8	0 6	3·7	3·6	1·9	
	1913	7·0	1·1	5·5	6·2	2·7	1·6
Sheep, over 1 year	1870	8·1	53·2	29·4	22·4	12·9	
	1913	9·1	59·1	29·1	21·2	17 0	26·6
Sheep, under 1 year	1870	2·8	38 4	18·9	15·1	6·4	
	1913	8·0	46·7	19·3	14·4	11·9	11·3

area remaining after arable, permanent grass, and rough grazings have been accounted for. In 1870 Shetland was merged with the Orkneys in respect of total area and no separate calculation is possible. Total grass excludes rough grazings.

APPENDIX B

Agricultural Returns for Selected Agrarian Regions, 1936

These tables have been calculated from the parish returns of the Ministry of Agriculture for 1936, each agrarian region comprising at least ten parishes. In calculating the acreage of grazing, grass put up for hay was eliminated as the returns refer to early June before the aftermath of the hayfields is available for grazing, and the rough grazings were adjusted by dividing them by 2 for marsh grazing, by 4 for down grazing, and by 10 for moor grazing.

	Breckland (Norfolk-Suffolk)	Good Sand (Norfolk)	Rich Loam (Norfolk)	High Suffolk (Suffolk)
Percentage of cultivated area				
Arable	71·9	79·9	85·3	74·3
Permanent grass	28·1	20·1	14·7	25·7
Percentage of arable				
Total grain crops	39·2	49·7	59·9	66·1
Total fallow crops	39·3	30·2	21·0	12·6
Rotation grass	8·0	15·8	16·4	15·6
Orchards and small fruit	4·4	0·3	2·2	0·3
Market garden and other crops	7·8	3·6	1·5	0·1
Bare fallow	1·6	0·8	—	5·4
Wheat	18·1	17·4	20·6	23·9
Barley	10·0	25·6	25·4	28·4
Oats	6·7	6·0	11·9	2·5
Beans and peas	0·7	0·6	0·8	11·3
Turnips and swedes	0·7	4·9	4·3	0·9
Mangolds	2·8	4·1	5·9	2·4
Potatoes	7·7	0·3	0·5	0·1
Sugar beet	24·9	15·6	9·3	7·1
Green fodder crops	3·2	5·3	1·0	2·1
No. per 100 acres of agricultural area				
Cows and heifers in milk	3·2	1·2	4·4	2·9
Cows and heifers in calf	1·4	0·6	1·3	0·9
Other cattle, over 2 years	1·7	1·9	1·7	1·2
Other cattle, 1–2 years	2·0	2·5	2·4	5·0
Other cattle, under 1 year	2·1	1·5	1·6	2·2
Total cattle	10·7	7·7	12·0	12·4
Breeding ewes	2·8	16·1	—	8·9
Lambs under 6 months	0·9	14·6	—	10·3
Other sheep over 1 year	0·2	2·4	—	0·4
Total sheep	4·0	34·6	0·2	22·0
Sows	3·5	1·4	5·1	5·6
Other pigs over 2 months	13·8	4·7	19·7	41·2
Total pigs	24·8	9·4	37·5	116·5
Total fowls	327	52	379	269
No. per 100 acres of grazing				
Cows and heifers in milk	13·3	4·9	26·4	16·2
Cows and heifers in calf	5·8	2·2	7·5	5·1
Other cattle, over 2 years	7·2	7·5	9·9	6·1
Other cattle, 1–2 years	8·5	10·0	14·6	28·2
Other cattle, under 1 year	8·8	6·0	10·7	12·6
Total cattle	44·5	31·0	72·1	70·0
Breeding ewes	11·8	64·5	0·1	50·3
Lambs under 6 months	3·6	58·8	—	58·5
Other sheep over 1 year	1·1	9·6	—	2·1
Total sheep	16·9	138·9	1·3	123·9
Total fowls	1364	211	2262	1511
Total horses	2·2	11·0	31·2	22·8

	Sandlings (Suffolk)	Cambridge Chalk (Cambs)	*Sittingbourne (Kent)	*Lower Greensand (Kent)
Percentage of cultivated area				
Arable	68·7	78·3	61·6	70·2
Permanent grass	31·3	21·7	38·4	29·8
Percentage of arable				
Total grain crops	48·8	58·1	18·4	12·3
Total fallow crops	28 1	16·8	13·1	5·7
Rotation grass	10·0	17·1	8·3	1·3
Orchards and small fruit	4·2	0·1	52·5	76·6
Market garden and other crops	8·1	1·7	7·6	2·1
Bare fallow	3 0	6·3	2·1	1·9
Wheat	9·1	25·9	7·4	5 9
Barley	16·0	18·5	2·2	0·6
Oats	17 2	9·5	5·9	3·6
Beans and peas	4·5	3·8	2·9	2·1
Turnips and swedes	6·3	3·8	1·2	1·0
Mangolds	3·2	1·9	1·4	1·0
Potatoes	2·8	0·2	6·3	2·1
Sugar beet	9·0	5·2	0·1	—
Green fodder crops	6·8	5·7	4·1	1·6
No per 100 acres of agricultural area				
Cows and heifers in milk	3·8	1·5	1·5	1·9
Cows and heifers in calf	2·5	0·5	0·8	0·7
Other cattle, over 2 years	0·6	1·4	2·2	0·5
Other cattle, 1–2 years	3·9	1·8	2·5	2·0
Other cattle, under 1 year	2·8	1·0	1·1	1 6
Total cattle	13·7	6·7	8·3	6·9
Breeding ewes	12·9	12·9	53·2	29·3
Lambs under 6 months	14·4	13·1	54·2	32·9
Other sheep over 1 year	2·3	1·4	37·7	15·1
Total sheep	29·8	28·9	156·7	81·1
Sows	2·7	1·6	1·7	2·2
Other pigs over 2 months	14·8	6·0	9·8	9·6
Total pigs	22·4	11·5	15 2	18·5
Total fowls	100	48	180	327
No. per 100 acres of grazing				
Cows and heifers in milk	13·5	7·0	4·4	11·2
Cows and heifers in calf	8·8	2·3	2·3	4·0
Other cattle, over 2 years	2·1	6·2	6·3	3·0
Other cattle, 1–2 years	13·9	8·2	7·3	12·2
Other cattle, under 1 year	10·0	4·7	3·3	9·8
Total cattle	48·9	30·6	23 8	41·1
Breeding ewes	45·8	58·7	152·1	174·8
Lambs under 6 months	51·2	60·0	155·6	196·4
Other sheep over 1 year	8·0	6·4	107·9	89·9
Total sheep	106·0	132·3	448·0	484·2
Total fowls	355	220	514	2351
Total horses	13·4	17·6	6·2	14·4

* In the Kent regions the density per 100 acres of grazing is unduly high, for many sheep are here grazed in grass orchards whose acreage is not included in the grazing as calculated above.

	Salisbury Plain (Wilts)	Downs Dorset (Dorset)	North Cotswolds (Glos.)	South Cotswolds (Glos.)
Percentage of cultivated area				
Arable	38·6	35·6	37·2	31·0
Permanent grass	61·4	64·4	62·8	69·0
Percentage of arable				
Total grain crops	52·1	41·3	42·9	36·4
Total fallow crops	20·8	25·5	10·3	8·0
Rotation grass	17·5	28·0	40·6	51·5
Orchards and small fruit	0·6	0·4	0·8	1·2
Market garden and other crops	1·2	0·5	1·7	0·9
Bare fallow	7·4	4·6	3·7	2·4
Wheat	23·9	15·1	21·8	17·3
Barley	10·6	9·4	4·4	6·7
Oats	16·4	15·7	15·3	11·5
Beans and peas	0·4	0·3	1·4	0·6
Turnips and swedes	4·1	18·1	3·8	4·2
Mangolds	1·6	2·1	1·3	0·7
Potatoes	2·8	0·3	0·4	1·3
Sugar beet	0·2	0·1	0·2	—
Green fodder crops	12·1	4·9	4·6	1·8
No. per 100 acres of agricultural area				
Cows and heifers in milk	6·0	8·5	5·2	5·4
Cows and heifers in calf	3·4	3·4	2·5	3·7
Other cattle, over 2 years	1·6	0 6	1·7	2·3
Other cattle, 1–2 years	1·9	1 9	5·5	6·2
Other cattle, under 1 year	1·9	2·0	5·0	4·2
Total cattle	15·1	16·8	20·3	22·8
Breeding ewes	29·4	29 8	18·1	11·0
Lambs under 6 months	32·5	8·6	20·0	12·8
Other sheep over 1 year	6·3	2·7	3·7	1·2
Total sheep	69·7	51·0	43·9	25·9
Sows	1·5	0·9	2·8	2·6
Other pigs over 2 months	4·5	2·7	11·2	12·2
Total pigs	10·2	6·1	19·6	21·8
Total fowls	76	81	102	227
No. per 100 acres of grazing				
Cows and heifers in milk	13·1	19·2	11·3	11·5
Cows and heifers in calf	7·4	5·8	5·3	7·8
Other cattle, over 2 years	3·4	1·6	3·7	4·9
Other cattle, 1–2 years	4·2	4·2	11 9	13·1
Other cattle, under 1 year	4·3	4·5	10·8	8·8
Total cattle	33·0	37·4	43·6	48·3
Breeding ewes	64·2	56·4	38·9	23·3
Lambs under 6 months	71·0	16·7	43·0	27·2
Other sheep over 1 year	13·8	5·0	7·9	2·6
Total sheep	152·1	96·5	94·4	55·0
Total fowls	166	203	219	480
Total horses	2·7	2·6	6·6	6·5

	Lincoln Marsh (Lincs)	Kesteven (Lincs)	Lincoln Heath (Lincs)	Mid-Lincoln Clay Vale (Lincs)
Percentage of cultivated area				
Arable	41·1	64·1	62·5	59·8
Permanent grass	58·9	35·9	37·5	40·2
Percentage of arable				
Total grain crops	65·8	56·0	54·1	59·2
Total fallow crops	10·6	22·6	22·0	15·8
Rotation grass	12·6	15·4	17·2	18·0
Orchards and small fruit	—	—	—	—
Market garden and other crops	5·1	4·0	3·4	3·0
Bare fallow	10·8	3·5	5·1	7·0
Wheat	30·5	23·4	29·9	30·1
Barley	6·6	23·2	9·9	11·8
Oats	11·2	5·5	8·9	11·3
Beans and peas	17·3	3·8	5·0	5·4
Turnips and swedes	2·8	9·2	3·6	6·1
Mangolds	1·7	2·0	1·6	1·8
Potatoes	0·4	1·3	7·3	1·2
Sugar beet	—	6·3	6·5	5·0
Green fodder crops	5·7	3·9	3·0	1·8
No. per 100 acres of agricultural area				
Cows and heifers in milk	6·8	2·4	3·3	3·7
Cows and heifers in calf	3·6	1·6	1·8	2·3
Other cattle, over 2 years	6·6	2·9	3 1	1·8
Other cattle, 1–2 years	7·0	3·3	5·4	4·0
Other cattle, under 1 year	6·4	2·8	3·4	4·4
Total cattle	30·6	13·2	17·2	16·1
Breeding ewes	16·9	18·1	20·0	20·9
Lambs under 6 months	18·8	19·8	22 0	22·8
Other sheep over 1 year	3·4	4·0	4·4	3·1
Total sheep	40·2	44·5	48·2	48·8
Sows	1·2	1·4	2·2	1·9
Other pigs over 2 months	4·9	4·0	7·0	5·8
Total pigs	9·8	8·3	14·7	13·3
Total fowls	314	132	167	253
No. per 100 acres of grazing				
Cows and heifers in milk	14·7	7·3	9·0	9·6
Cows and heifers in calf	7·8	4·8	4·8	5·3
Other cattle, over 2 years	14·4	8·6	8·4	4·6
Other cattle, 1–2 years	15·1	9·9	14·4	10·4
Other cattle, under 1 year	13·9	8·4	9·0	11·3
Total cattle	66·3	39·7	46·4	40·9
Breeding ewes	36·7	54·3	53·9	54·1
Lambs under 6 months	40·7	59·5	59·2	59·0
Other sheep over 1 year	7·4	11·9	11·8	8·1
Total sheep	87·1	133·3	130·0	126·2
Total fowls	682	396	452	653
Total horses	7 2	6·8	8·3	7·9

	Holland (Lincs)	Yorks Wolds (Yorks)	Holderness (Yorks)	Vale of Devon (Devon)
Percentage of cultivated area				
Arable	81·7	82·8	54·0	41·0
Permanent grass	18·3	17·2	46·0	59·0
Percentage of arable				
Total grain crops	40·7	56·6	66·2	43·6
Total fallow crops	42·9	23·7	8·6	16·4
Rotation grass	3·7	19·3	12·5	32·5
Orchards and small fruit	3·6	0·1	0·3	6·2
Market garden and other crops	14·3	0·4	3·1	0·5
Bare fallow	1·2	0·3	11·0	0·8
Wheat	21·3	22·5	36·5	14·8
Barley	2·9	18·2	2·5	3·2
Oats	8·2	15·4	15·4	21·4
Beans and peas	8·3	0·4	12·0	—
Turnips and swedes	0·5	18·1	1·2	8·0
Mangolds	1·4	0·6	1·8	4·0
Potatoes	31·2	0·1	0·4	0·9
Sugar beet	8·8	0·9	0·4	0·2
Green fodder crops	1·0	4·0	4·8	3·3
No. per 100 acres of agricultural area				
Cows and heifers in milk	2·4	1·7	4·6	5·3
Cows and heifers in calf	1·1	0·6	2·2	1·9
Other cattle, over 2 years	3·3	1·2	5·3	3·4
Other cattle, 1–2 years	3·9	2·3	4·6	6·0
Other cattle, under 1 year	2·7	1·6	3·6	5·8
Total cattle	13·6	7·4	20·6	22·5
Breeding ewes	1·9	25·0	23·4	34·0
Lambs under 6 months	1·9	33·5	30·2	25·7
Other sheep over 1 year	1·8	5·1	0·4	3·2
Total sheep	5·9	67·8	56·8	65·2
Sows	3·9	1·4	3·3	2·7
Other pigs over 2 months	18·5	6·6	13·9	15·8
Total pigs	31·6	11·5	24·3	26·3
Total fowls	241	108	215	187
No. per 100 acres of grazing				
Cows and heifers in milk	14·9	5·7	11·3	10·3
Cows and heifers in calf	7·1	2·0	5·3	3·6
Other cattle, over 2 years	20·9	3·8	13·6	6·7
Other cattle, 1–2 years	24·5	7·3	11·3	11·5
Other cattle, under 1 year	17·2	5·0	8·9	11·2
Total cattle	83·8	24·0	50·6	43·6
Breeding ewes	12·2	80·9	57·6	65·8
Lambs under 6 months	11·8	108·4	74·6	49·7
Other sheep over 1 year	11·3	16·5	0·9	6·2
Total sheep	37·0	219·3	139·5	125·7
Total fowls	1514	349	530	363
Total horses	32·9	3·6	9·9	4·9

	Vale of Taunton (Som.)	Somerset Allu-vium (Som.)	Vale of N. Wilts (Wilts)	Black-more Vale (Dorset)
Percentage of cultivated area				
Arable	32·8	6·5	12·1	6·4
Permanent grass	67·2	93·5	87·9	93·6
Percentage of arable				
Total grain crops	47·2	29·7	46·6	51·3
Total fallow crops	18·6	13·5	14·9	16·3
Rotation grass	22·8	14·3	31·0	17·2
Orchards and small fruit	9·8	37·8	1·7	10·0
Market garden and other crops	1·5	1·4	2·3	1·1
Bare fallow	1·3	3·3	4·6	4·3
Wheat	12·7	17·4	26·2	23·4
Barley	25·1	0·3	2·7	10·1
Oats	6·6	8·1	15·6	14·0
Beans and peas	2·5	3·1	1·9	3·5
Turnips and swedes	8·4	2·5	5·6	3·3
Mangolds	4·9	5·9	4·3	6·8
Potatoes	1·1	2·6	2·9	1·5
Sugar beet	0·3	—	0·1	—
Green fodder crops	3·9	2·2	2·0	4·7
No. per 100 acres of agricultural area				
Cows and heifers in milk	8·9	21·8	19·3	19·4
Cows and heifers in calf	2·8	5·1	6·1	4·7
Other cattle, over 2 years	4·6	4·9	1·1	4·5
Other cattle, 1–2 years	6·9	4·0	3·1	4·0
Other cattle, under 1 year	5·8	4·1	3·3	4·0
Total cattle	29·5	41·0	33·6	37·6
Breeding ewes	31·3	15·3	5·1	3·8
Lambs under 6 months	20·2	17·7	5·8	1·8
Other sheep over 1 year	4·2	7·2	0·5	0·5
Total sheep	60·5	43·0	11·8	6·7
Sows	2·4	0·8	1·9	1·8
Other pigs over 2 months	13·3	7·6	8·7	10·1
Total pigs	22·0	10·2	14·8	10·8
Total fowls	287	272	192	194
No. per 100 acres of grazing				
Cows and heifers in milk	18·4	36·7	42·6	33·9
Cows and heifers in calf	5·9	8·5	13·5	8·2
Other cattle, over 2 years	9·4	8·2	2·3	7·9
Other cattle, 1–2 years	14·2	6·7	6·8	7·0
Other cattle, under 1 year	11·9	6·9	7·2	7·0
Total cattle	60·7	69·1	74·1	65·4
Breeding ewes	64·5	25·7	11·4	6·6
Lambs under 6 months	41·5	29·8	12·8	3·2
Other sheep over 1 year	8·6	12·2	1·2	0·9
Total sheep	124·5	72·4	26·1	11·7
Total fowls	591	458	423	338
Total horses	6·8	6·3	6·3	5·0

	South Essex (Essex)	Market Harborough (Leics.)	Melton Mowbray (Leics.)
Percentage of cultivated area			
Arable	32·3	3·4	7·0
Permanent grass	67·7	96·6	93·0
Percentage of arable			
Total grain crops	55·3	52·6	57·5
Total fallow crops	17·3	13·3	10·5
Rotation grass	10·7	25·3	24·7
Orchards and small fruit	7·4	1·1	0·8
Market garden and other crops	3·5	3·0	0·4
Bare fallow	8·0	5·2	6·2
Wheat	25·7	27·0	34·9
Barley	11·1	3·1	3·9
Oats	12·3	22·3	12·6
Beans and peas	6·2	—	6·0
Turnips and swedes	0·7	4·6	0·8
Mangolds	3·8	5·9	5·7
Potatoes	5·8	1·7	0·9
Sugar beet	1·3	—	0·6
Green fodder crops	5·7	1·1	2·5
No. per 100 acres of agricultural area			
Cows and heifers in milk	10·7	5·3	8·8
Cows and heifers in calf	4·2	3·2	4·0
Other cattle, over 2 years	2·5	32·4	10·0
Other cattle, 1–2 years	4·2	4·8	5·9
Other cattle, under 1 year	2·9	2·9	3·9
Total cattle	25·[illegible]	48·9	33·0
Breeding ewes	10·0	31·7	23·5
Lambs under 6 months	10·2	40·9	33·4
Other sheep over 1 year	0·1	14·8	3·9
Total sheep	20·7	90·2	62·0
Sows	1·8	0·5	0·5
Other pigs over 2 months	6·1	2·5	2·7
Total pigs	12·9	3·5	4·3
Total fowls	661	112	263
No. per 100 acres of grazing			
Cows and heifers in milk	23·2	6·9	14·0
Cows and heifers in calf	9·1	4·2	6·3
Other cattle, over 2 years	5·5	41·8	15·9
Other cattle, 1–2 years	9·1	6·3	9·4
Other cattle, under 1 year	6·4	3·7	6·1
Total cattle	55·1	63·2	52·4
Breeding ewes	21·8	40·9	37·4
Lambs under 6 months	22·2	52·8	53·1
Other sheep over 1 year	0·3	19·1	6·1
Total sheep	45·0	116·5	98·4
Total fowls	1437	144	417
Total horses	6·7	3·1	5·0

	Upper Wensleydale (Yorkshire)	Lower Wensleydale (Yorkshire)	Craven (Yorkshire)
Percentage of cultivated area			
Arable	0·4	21·8	0·2
Permanent grass	99·6	78·2	99·8
Percentage of arable			
Total grain crops	5·6	54·2	17·1
Total fallow crops	20·8	25·1	23·1
Rotation grass	67·7	15·1	57·1
Orchards and small fruit	—	0·4	2·6
Market garden and other crops	7 9	3·1	—
Bare fallow	—	2·5	—
Wheat	—	9·3	—
Barley	—	29·3	—
Oats	3·4	15·0	17·0
Beans and peas	1·1	0·1	—
Turnips and swedes	4·5	13·7	5·1
Mangolds	—	3·6	2·6
Potatoes	9·5	5·2	10·3
Sugar beet	—	1·0	—
Green fodder crops	6·8	1·6	5·1
No. per 100 acres of agricultural area			
Cows and heifers in milk	7·7	6·2	8·3
Cows and heifers in calf	4·8	3·2	9·4
Other cattle, over 2 years	1·6	6·2	5·3
Other cattle, 1–2 years	3·4	5·9	4·3
Other cattle, under 1 year	2·9	5·7	4·4
Total cattle	21·1	28·0	32·3
Breeding ewes	82·1	35·6	61·3
Lambs under 6 months	86·7	47·6	69·6
Other sheep over 1 year	11·1	5·2	7·9
Total sheep	189·7	91·7	141·8
Sows	—	0·6	0·2
Other pigs over 2 months	1·0	5·1	1·0
Total pigs	1·2	6·7	1·5
Total fowls	75	207	149
No. per 100 acres of grazing			
Cows and heifers in milk	9·8	12·3	10·6
Cows and heifers in calf	6·1	6·1	11·9
Other cattle, over 2 years	2·0	12·2	6·7
Other cattle, 1–2 years	4·4	11·2	5·4
Other cattle, under 1 year	3·7	10·9	5·6
Total cattle	26·9	53·8	41·0
Breeding ewes	104·4	68 4	77·1
Lambs under 6 months	110·2	91·5	88·3
Other sheep over 1 year	14·1	9·9	10·0
Total sheep	241·2	176·1	179·8
Total fowls	91	398	189
Total horses	2·0	6·0	2·1

APPENDIX C

Location of Industry by Materials

I

THIS appendix deals with only one facet of the vast and complicated landscape of industrial location, the extent to which industry is located by the materials which it employs. The foregoing chapters have shown that industry is not a single unit but a collection of diverse and highly differential parts, each with its own locational requirements and its own particular relationship to a particular set of materials. It has also been shown that industries differ among themselves in the closeness of their fixation by materials, that, for example, blast furnaces are in close proximity to ore or coal, but that engineering is more widely dispersed, at Crewe and Ipswich equally with Manchester and the Black Country, and may be completely removed from coal and ore altogether. In previous chapters attention has been directed chiefly to the variation in these respects within a particular group or sequence of industries. This appendix extends the field of inquiry to the whole range of industry on a common ground and attempts to devise tests which will permit the classification of a wide diversity of industry on a common list in reference to the degree to which each industry is located by its materials.

My first work on this problem was a report published in 1942 entitled *The Distribution of Population and the Location of Industry on Merseyside.*[1] Professor Sargent Florence with his collaborators has since worked also in this field, particularly in *Investment, Location and Size of Plant,*[2] and in order to define heaviness of industry has used the four tests I employed in 1942 with the addition of a fifth. His concern with degree of heaviness of industry and my concern with degree of fixation to materials are not identical, as will appear. In my original work of 1942 I confined my attention to the type of industry located on Merseyside, but I have since worked through the whole range of British factory industry and this appendix embodies my conclusions to date. Most of the evidence is drawn from the Fifth Census of Production. It is possible from this evidence to devise tests in order to classify industries into groups in degree of fixation by materials. I propose to examine each test in turn, to estimate its value and to discuss its deficiencies as an efficient instrument for this purpose. The tests I shall consider are: (1) cost of materials as a percentage of gross output, (2) weight of materials per operative, (3) value of product per ton, (4) proportion of males in total operatives, (5) horse-power per operative.[3]

II

The first test (col. 3 of the table) I propose to consider is that of cost of materials as a percentage of gross output, which is by definition the net selling value of the products made. This is not the most satisfactory

[1] W. Smith, *The Distribution of Population and the Location of Industry on Merseyside* (1942).

[2] P. Sargent Florence, assisted by W. Baldamus, *Investment, Location and Size of Plant* (1948).

[3] For a preliminary statement see W. Smith, 'Mobility in the Location of Industry in Great Britain', *The Advancement of Science*, vol. VI, no. 22 (1949), pp. 115–17.

test, as I shall show, but it is easy to calculate for *all* industries, which is not true of all tests, and it serves as a useful introduction to the problems involved. If the percentage cost of materials be high and if cost of materials bulks large in cost of production, it would seem reasonable to infer that the industry is likely to be located close to its materials. If it is low, it would seem reasonable to infer that cost of materials is less significant and that the industry is free to be located elsewhere than close to its materials. Let me give an example. In blast furnace work the cost of materials[1] was in 1935 79 per cent of the value of the gross output and it is common knowledge that blast furnaces, with very few exceptions, are located close to coal or ore. But in steel works and rolling mills it was 62 per cent, in mechanical engineering 41 per cent and in foundry work 39 per cent. Steel works and rolling mills, in fact, though commonly on coalfields or orefields, are less completely tied to coal and ore, while engineering shops and foundries are widely dispersed, foundries being found in every town and engineering shops in most. There is, as Census of Population and Ministry of Labour data show, a reasonably close correspondence between the larger regional distribution of those employed in engineering and of the total working population (see Table L). The facts of location thus coincide with the evidence of this test of cost of materials. Let me give a further example. In grain milling cost of materials was 73 per cent of value of gross output, but in baking 55 per cent. Grain milling is focused at the grain importing ports and in corn-growing districts, though there are some mills in inland industrial centres, while baking is widely dispersed, though not exactly in strict proportion to population. The test is again valid. Many other examples could be given. The making of sweets, on this test, is more mobile with regard to materials than sugar refining, the making of soap and paints than seed crushing. Within a given sequence of industries, using the same materials but in a more and more manufactured form, the locational tie to the original material becomes more and more tenuous and the industry making the finished product ready for consumption free to be located elsewhere.

But, while a useful instrument within a sequence of industries, the test loses its delicacy when industries of very different kind are placed side by side in a common list and its validity is actually destroyed in respect of certain forms of manufacture. Let me give some examples of its deficiencies. The first is the effect of the structure of the industry. There are neat examples in the textile trades. In 1935 cost of materials was 67 per cent of the gross output in worsted spinning, but 47 per cent in woollen manufacture, which includes both woollen spinning and woollen weaving. This is a most striking contrast. Both industries employ wool, but in West Yorkshire, which dominates the country's total, there is a sharp distinction in structure between them. In the woollen all processes, except dyeing, are integrated on the same site, but in the worsted disintegration is common, spinners being separate from weavers. In an integrated mill the work on the material comprises both spinning and weaving, but in a specialist spinning mill or weaving shed the work is limited to one of these alone. The amount of the raw material, wool, is the same, but there is a greater

[1] Including coal other than that used for power, according to the proportions of 1930.

aggregate of labour costs in the integrated premises and the cost-of-material percentage, therefore, is lower. Fortunately, the Report on the Fifth Census submits for the larger industrial groups an estimate of production free from duplication. For the woollen and worsted trades as a whole free from duplication, cost of materials was approximately 47–48 per cent, a figure almost identical with that for the integrated woollen industry. In cotton the percentage was 70 per cent in spinning and 69 per cent in weaving, but 57–58 per cent in the industry as a whole free from duplication. Such adjustments for duplication improve the efficiency of the cost-of-materials test very considerably. In the classification of 72 industries in the table appended the estimates free from duplication have been used wherever available.[1] There is a second defect of this test in respect of industrial structure which I want to notice. In motor car manufacture the cost-of-materials percentage was 51 in 1924, 58 in 1930 and 59 in 1935. The trend of change in most industries is for the cost-of-materials percentage to decline, which makes the increase in the motor-car trade all the more striking. The date of the change in percentage is very significant. It came at the time, between 1924 and 1930, when motor-car firms were adopting flow systems of assembly and when labour costs, high in the initial handicraft phases, were consequently being reduced.[2] It is the rule for a handicraft industry to have a lower cost-of-materials percentage than a factory industry. Retail bespoke tailoring, for example, has a lower cost-of-materials percentage than wholesale factory tailoring. It may, therefore, be concluded that there is a difference in the cost-of-materials percentage according to stage of economic development, whether handicraft or factory, as well as according to industrial structure, integration of processes within the same establishment or disintegration between many. Alfred Weber noticed the same point and drew significant location inferences from it. There is a third deficiency of this test. In the brick and fire-clay trade the cost-of-materials percentage was 23, a very low figure indeed. Yet the industry uses great quantities of clay and is invariably on the site of clay pits, frequently owned by the same firm. It is immobile on other tests. In the Fifth Census firms made no separate return for their clay pits and it would appear that where the clay is not purchased it is frequently not included in cost of materials and that in consequence this test gives an entirely fictitious result in this particular trade. There is a fourth deficiency in that the industries working on commission, such as textile finishing, have also a very low cost-of-materials percentage, for they do not purchase the product on which they are working.

In view of these examples it can only be concluded that, while a test derived from cost of materials is of considerable value, it must be used with discretion and cannot be regarded as an automatic index of degree of mobility. It can be improved where duplication can be eliminated and it could be improved still more if adjustments could be made for differences in stage and nature of economic organization. The last two deficiencies specified in the preceding paragraph could be met only by means of

[1] I did not use them in 1942 and Professor Sargent Florence does not appear to have used them in the construction of his tables.

[2] Professor Sargent Florence has pointed out in a review in the *Economic Journal* (Dec. 1949) that this might alternatively be due to disintegration, that is, the first deficiency discussed in this paragraph.

valuations of materials not purchased. In the present form of the evidence, the value of the test varies from industry to industry.

The second test (col. 1 of the table) I propose to consider is the weight of material employed in the manufacturing process. If the weight be substantial, then it is reasonable to expect the industry to be tied to the source of its materials. The ratio I shall use is the weight of material per operative, as this establishes a relationship between two quantities whose variations are opposite to each other. As returned to the Fifth Census of Production (including coal not used for power but without adjustment according to size of sample and without adjustment owing to duplication) this was in 1935 over 1700 tons per operative in blast furnaces, nearly 150 tons in steel works and rolling mills, 29 tons in foundries and 9 tons in engineering shops. In grain milling it was 373 tons, in baking 26 tons. There are the same sort of differences between sugar refining and sugar confectionery, between seed crushing and soap and paints. There is a much wider dispersion between the lowest and the highest values on this than on the first test and those industries with a high weight-of-materials index stand out very prominently from the rest. With a wider dispersion the index may be expected to have a greater sensitivity. There is a bunching of industries with a low weight-of-materials index and many have a lower status with regard to fixation by materials on the second than on the first test. Prominent among these are the textile trades. It is not generally realized how small are the weights of materials handled by the textile industries when these are related to the number of operatives at work on them. They have a higher status on the first test because their materials are relatively valuable in proportion to their weight. This is in itself a further criticism of the validity of the first test.

This second test, however, despite its supreme value on theoretical grounds, has a very grave practical deficiency. For many industries it is impossible to calculate an index from the weight particulars given in the Census tables. Expressed as a percentage of the value of all materials and fuels employed, weights are obtainable, to give some random examples, for only 47 per cent in mechanical engineering, 55 per cent in biscuits, 32 per cent in agricultural engineering, 21 per cent in boots and shoes, 16 per cent in hats and caps. For several industries there are no weights given whatsoever, except for coal. This is a very serious practical deficiency in the construction of a test designed to apply to the whole range of industry. The deficiency may be limited, though not corrected, by adjusting the weight of materials according to the size of the sample on the assumption that the weight of the recorded items is in the same proportion to value as the weight of recorded items. I once thought some solution was possible along these lines, but I am now of the opinion that this assumption is unjustified. Over the whole range of industry the heavier industries have a greater proportion of their materials specified by weight than have the lighter industries and it is presumably the lighter materials whose weights are unspecified. Nevertheless, in the classification table appended I have made such adjustments according to size of sample on the grounds that the adjusted figures display fewer errors, though errors they do contain, than the unadjusted when placed on a common list. There is a further deficiency of this test in addition to the practical difficulty of calculating it. It is probable that some materials used in large

quantities are unrecorded in the Census tables in weight and in value. The example of clay in the brick and fire-clay trades has already been mentioned. The vast quantities of water used by textile finishers and by paper-makers are probably also unrecorded except where purchased from town mains, for they are largely drawn from private bore-holes or from streams by virtue of water rights. Such materials may be the most important of all in determining location in a particular case. I say this despite Weber's classification of water as an ubiquity and his dismissal of it as a localizing factor. It is sometimes a localizing factor of the profoundest importance.

It may be concluded for this second test, as for the first, that, while valuable, it cannot be regarded as an automatic index in its present imperfect form. It is capable of refinement if weights could be specified for a wider range of materials in the manufacturer's returns and it is almost certainly capable of greater ultimate refinement than the first test, which is complicated by the complex industrial structure of the country and by the varying ratio between weight and value of materials. The second test may be regarded as more reliable than the first.

The third test (col. 2 of the table) in many ways is correlative with the one just considered. This is the value of product per ton. Most industries employing a large bulk of materials make a product relatively low in value. Blast furnace work, brick making, grain milling, sugar refining, the mixing and making-up of cattle foods all spring to the mind as examples. Conversely, industries using a small bulk of materials frequently make an article high in value in proportion to weight. Tailoring, cutlery and tobacco are obvious examples. There is a greater agreement between these two classifications, weight of materials per operative and value of product per ton, than between any other of the classifications considered. The most prominent divergencies are themselves significant. Those with a higher rank in weight of materials than in value of product include metal smelting and rolling, seed crushing, butter, cheese and margarine manufacture, in all of which there is a large loss of weight in respect of the *main* product in the course of manufacture. Those with a higher rank in value of product than in weight of materials include baking, tin box and cardboard box making, whose products take up more space than the materials from which they are made. If water be ignored as a raw material, the products of baking display an actual gain in weight. As Weber pointed out in a well-known passage, the weight-losing industries are pulled to the source of materials. It may be added that conversely the space-gaining tend to be located at the point of consumption.

This third test is subject to the same practical defects as the second. It is usually calculable for only a proportion of the output of each industry.

A fourth test (col. 5 of the table) of a heavy industry is the proportion of males in the total operative force. It may also be indirectly a test of fixation to materials, which is the concern of this essay, but only if a large proportion of males is a result of the great weights handled. There is a high proportion of males in shoe repairing and a fairly high proportion in scientific and musical instrument making, but the weights handled in these instances are very small and these particular examples cannot be described as heavy in any sense of the term, and they are certainly not fixed by their materials. The engineering trades also have a higher rank in percentage

of males than in weight of materials. They may be heavy in respect of equipment, but not all branches of engineering are heavy in respect of bulk of materials. Moreover, we are now familiar with rapidly changing sex proportions in industry under the conditions of a war-time economy and there is clearly no permanence in the sex proportions in any industry at any particular date. My conclusion is that, while the proportion of males is a useful test of heaviness of industry, it is secondary to weight of materials and to value of product as a test of fixation by materials and is likely to be unreliable as a primary source of evidence.

Professor Sargent Florence proposes the addition of a fifth test (col. 4 of the table), that of horse-power per operative employed. This is obviously a valid test for his purpose, the measuring of the relative heaviness of an industry, and he finds it to be second in value to weight of materials. It is to be expected that industries using bulky materials will have a large quantity of machine equipment to handle them. Nevertheless, the classification according to horse-power and the classification according to weight of materials do not everywhere coincide. The textile industries, for example, have a higher status in horse-power than in weight of materials, for their materials are low in weight but subjected to many successive mechanical processes. The same is true of engineering shops. Conversely, baking, brick and fire-clay, china and earthenware all have a lower rank in horse-power than in weight of materials, for they are oven or kiln industries requiring only a limited amount of engine drive. Further, blast furnaces, though in the first rank in horse-power, have not a horse-power in proportion to their great bulk of materials. These deficiencies make this horse-power test of low efficiency in testing fixation to materials. It is, in fact, a secondary rather than a primary test for my purpose, despite its value in defining heaviness.

It will be clear that each of the tests considered have deficiencies, however valuable and significant the tests individually may be. Moreover, the relative value of each test varies with the nature and characteristics of each industry. Some of these deficiencies are inherent in the nature of the test, but some are remediable and can be corrected by more detailed information. It is not yet possible to construct a completely sensitive index in which each industry falls into place and which covers the entire range of British factory manufacture. It may indeed never be possible to calculate a sufficiently highly sensitive index on account of the extreme complexity and fluidity of industrial structure and on account of the wide variation between industries in relation to the conditions of each of these different tests. Moreover, the precise position of each industry in the hierarchy is liable to change with changes in industrial technique. But, although these tests do not provide a key to unlock all mysteries, I submit that their employment does permit a reasonable approach to this particular facet of the problem of the location of industry.

III

From the evidence discussed above I have constructed a table placing in order of fixation by materials some seventy-two industries for which evidence is available on each of these tests. For those other industries not included in the table information is deficient on one or more tests. The

number of industries included is statistically convenient for it permits division into eight groups. The method of construction of the table requires but little explanation. On each test each industry was given a rank and the complete sequence 1–72 was then divided into eight groups, each consisting of nine industries. When once classified within a particular group on any test the precise relative position within that group was subsequently ignored with reference to that particular test. I adopted groups A–H rather than the more detailed ranking 1–72 on account of the imperfection of the material: a more detailed ranking would have given an illusion of accuracy which the table would not, in fact, possess. Even with eight groups there may well be false classification along the borders between two groups as a result again of the inadequacy of the data. I have taken weight of material per operative as the primary classification and then, in order of decreasing significance, value of product per ton, and cost of materials as a percentage of gross output. Rank according to horse-power per operative and according to percentage of males has been added for comparative purposes. This method has been adopted after many experiments. An average ranking was worked out, regarding each test as of equal value, and also a ranking on a points system, whereby the greatest number of points was attached to weight of materials and progressively lesser number of points to value of product per ton, to cost of materials as a percentage of gross output, to horse-power per operative, and to percentage of males. The results obtained were similar when expressed in general terms particularly with regard to those industries of high and low mobility with regard to materials, but individual industries, of course, moved backwards or forwards in the classification particularly in the middle ranges of the list. Neither of these alternatives are satisfactory on theoretical grounds for the object of this essay is not an average or an aggregate of several diverse tests but simply a test of degree of fixation by materials. The average or the aggregate is more significant in an attempt to measure the heaviness of industry, for that term is itself composite and is concerned with the weight of the equipment employed as well as with the weight of materials consumed in the course of manufacture.

The industries which stand out at the head of the list as fixed closely by the provenance of materials are, in approximately decreasing order of intensity, manufactured fuel, coke and by-products, blast furnaces, grain milling, petroleum, fertilizer, cement, brick and fire-clay, sugar, glass, seed crushing, cattle and poultry food, steel works and rolling mills, paper, chemicals, fish curing, oil and tallow, butter and cheese and margarine. Those which stand at the bottom of the list are aircraft, cutlery, needle and pin and metal smallwares, tobacco, lace, tailoring and dressmaking, hosiery. On the evidence of the tests employed above these display almost complete mobility with regard to materials, though, it is important to note, not necessarily with regard to other localizing factors. Not all of these mobile industries are widely diffused over the face of the country, as complete mobility with regard to materials would permit. Some are fixed in one or more places by factors other than the materials which they employ. But the analysis of these other factors is another problem and is not the concern of this appendix.[1]

[1] See W. Smith. *Geography and the Location of Industry. An Inaugural Lecture* (1952).

CLASSIFICATION OF INDUSTRIES IN BRITAIN IN DEGREE OF MOBILITY WITH REGARD TO MATERIALS

A=Least Mobile. H=Most Mobile.

(1) According to weight of materials used per operative in 1935, including coal other than that used for power generation (on the 1930 proportions).
(2) According to value of product per ton in 1935.
(3) According to cost of materials as a percentage of gross output in 1935, including coal other than that used for power generation (on the 1930 proportions) in materials.
(4) According to horse-power per operative in 1930.
(5) According to percentage of males in total operatives in 1935.

	(1)	(2)	(3)	(4)	(5)
Manufactured fuel	A	A	A	A	A
Coke and by-products	A	A	A/B	A	A
Blast furnaces	A	A	A/B	A	A
Grain milling	A	A	A/B	A	B/C
Petroleum	A	A	C	A	A
Fertilizer	A	A	C	B	D
Cement	A	A	H	A	A
Brick and fire-clay	A	A	H	C	C
Sugar and glucose	A	B	A	B	C
Cattle, dog and poultry foods	B	A	B	C	D
Glass	B	B	H	D	D
Seed crushing	B	B	A	A	A
Steel works and rolling mills	B	B	C	A	A
Paper	B	B	D	A	E
Chemicals, dye stuffs and drugs	B	B	F	B	D
Fish curing	B	C	A	H	G
Oil and tallow	B	C	B	D	C
Butter, cheese, condensed milk and margarine	B	D	A	D	E
Tinplate	C	B	B	B	B
Foundries	C	B	F/G	E	B
Wire	C	C	C	B	D
Wrought iron and steel tube	C	C	C/D	B	B
Brewing and malting	C	C	H	E	C
Soap, candle and perfumery	C	D	E	E	F
Paint, colour and varnish	C	D	F	C	D
China and earthenware	C	D	H	H	F
Aluminium, tin, lead, etc., smelting and rolling	C	E	B	C	C
Bread, cakes, etc.	D	B	C/D	G	D
Railway carriage and wagon building	D	C	C	B	A
Copper and brass smelting and rolling	D	E	B	B	B
Linoleum and oilcloth	D	E	E	B	B/C
Starch and polishes	D	E	F/G	F	F
Preserved foods	D	E/F	C	G	G/H
Bacon-curing and sausage	D	F	A	F	E
Wholesale bottling	D	F	A	G	F
Manufactured abrasives	D	G	F	D	C
Cardboard box	E	C	E	H	H
Asbestos	E	C	G	D	E
Chain, nail, screw, etc.	E	D	E	E	E
Mechanical engineering	E	E	F/G	D	B
Wallpaper	E	E	G	F	E
Ink, gum, etc.	E	E/F	F/G	C	E
Cocoa and sugar confectionery	E	F	D/E	F	H
Jute	E/F	D	D	E	G
Prime mover and boiler	E/F	F	E	C	A
Biscuit	E/F	F	F	G	G/H

	(1)	(2)	(3)	(4)	(5)
Leather tanning and dressing	E/F	G	B	D	C
Tin box	F	D	C	G	F/G
Hardware and hollow-ware	F	D	E	G	F
Agricultural machinery	F	F	F	F	B
Aerated waters, etc.	F/G	C	G	G	E
Manufactured stationery	F/G	D	F	H	G
Textile machinery	F/G	F	G	E	B/C
Rubber	F/G	G	E	C	F
Electrical engineering	F/G	G	F	F	E
Canvas goods and sack	G	E	A/B	G	H
Rope, twine and net	G	E	C	E	G
Coir fibre, horse-hair, etc.	G	F	B	E	F
Motor and cycle	G	G	G	F	D
Tool and implement	G	G	G/H	D	D
Machine tools	G	G	H	C	B
Silk and artificial silk	G	H	D/E	E	F/C
Cotton	G	G	C/D	C	G
Linen and hemp	H	G	D	F	H
Woollen and worsted	H	H	D	D	G
Hosiery	H	H	D	H	H
Tailoring, dressmaking, etc.	H	H	D	H	H
Lace	H	H	E	H	F/C
Tobacco	H	H	F[1]	H	H
Needle, pin and metal smallwares	H	H	G/H	H	G/H
Cutlery	H	H	H	F	F
Aircraft	H	H	H	G	B

[1] Excluding customs or excise duties.

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